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A CONTRACT FOR THREE MILES of 42-in. steel force main at Duluth, Minn., has been awarded to Mr. N. F. Hugo for $117,000. The plates will be rolled by the Ironton Structural Steel Co., of Duluth, and the pipe will be shaped and riveted by Mr. Hugo. A contract will soon be let for laying 1,500 ft. of 60-in. steel intake pipe, now on the shore ready to be put in place. The shore end of the intake will be in 20 ft. and the outer end in 60 ft. of water. The pipe will be laid in a trench excavated in solid rock. Mr. W. B. Patton is city engineer and Mr. E. J. Duffies is assistant engineer.

THE DANUBE SHIP CANAL, through the Iron Gates, was formally opened to traffic, on Sept. 27, in the presence of the Emperor of Austria and the Kings of Roumania and Servia. Owing to the obstructions in the Danube, between Alt-Orsova, in Hungary, and Gladova, in Servia, the passage down the river for boats drawing 5 ft. or more of water was impracticable for 117 days out of the 225 days in which navigation is nominally open. And for boats drawing 6 ft. of water the river was never navigable between Bazias and the Iron Gates, a distance of nearly 80 miles. The rock dikes across the river have been now removed and a canal has been cut through the obstructions at the Iron Gates, this canal being about two miles long, 200 ft. wide and 10 ft. deep. The river has now been made navigable, for vessels drawing not more than 10 ft., from Vienna to the Black Sea, at a cost of about $10,000,000.

THE ERIE CANAL TRACTION CO. is reported as sold to an English syndicate for $3,000,000, though the exact terms and proportion of stock transferred are not yet known. The sale was made by the Cataract General Electric Co. and it covers the right to construct an electric towing system along the canal. Meanwhile the right of the Cataract General Electric Co. to erect poles along the canal and the validity of the franchise generally are being questioned by interested parties, on the ground that the franchise for the installation of an electric towing system was obtained through political intrigue and without compensation to the state.

THE LAKE ERIE AND OHIO RIVER SHIP CANAL report, which cost about $35,000, lies in the vaults of the Pittsburg Chamber of Commerce from lack of funds for compilation and publication. It seems that the city of Pittsburg has not yet turned over its appropriation for the canal and appeals to the public have been as yet unavailing.

THE TWELVE NEW LAKE STEAMERS of the Bessemer Steamship Co., controlled by Mr. John D. Rockefeller, which are designed for carrying the iron ore of the Mesabi range from Duluth to Cleveland and other lake ports, are to be given the names of great engineers. The flagship is the "Sir Henry Bessemer," and the others are to be named "Stephenson," "Ericsson," "Corliss," "Krupp," "Fulton," "Watt," "Siemens," "Bell," "Fairbairn," and "Holley." The steamers are each designed to carry 4,000 gross tons on a draft of 14 ft. It is said that these vessels will be able to carry ore from Duluth to Cleveland as low as 50 cts. per ton, which should materially decrease the cost of making pig iron in Pennsylvania and Ohio from Lake Superior ores.

TWO LARGE STEEL STEAMERS, for use in the Lake trade, are now approaching completion. The largest of these, the "George Stephenson," is being built at Bay City. Its dimensions are 428 ft. long over all, 408 ft. between perpendiculars, 48 ft. beam, 28 ft. depth of hold. The triple expansion engine has cylinders 25, 40 and 67 ins. diameter and 44 ins. stroke. There are three Scotch boilers, each 13 ft. 3 ins. diameter and 12 ft. 3 ins. long. The propeller is 13 ft. 6 ins. diameter and 17 ft. 6 ins. pitch. The estimated carrying capacity of the vessel is 4,000 gross tons on 14 ft. 6 ins. draft. On Sept. 23, the "James Watt," was launched at Cleveland, Ohio. This ship is 426 ft. long over all, 48 ft. beam and 29 ft. in minimum depth of hold. She cost $260,000 and is built to carry 4,000 tons of ore on a draft of 14. ft. 6 ins., and 6,000 tons on 18 ft. 6 ins. Both these huge freight carriers are owned by Mr. John D. Rockefeller, and are to be used to carry ore from his extensive mines in the Mesaba Range.

THE SINGULAR STEAMER "HOWARD CASSARD" has been sold at auction in Baltimore for $1,000. The vessel was long and narrow, so narrow as to be very unstable, but the inventor's idea was to drive it so fast (35 to 40 miles per hour) as to give it an artificial stability. The hull is 220 ft. long, 16 ft. extreme beam, and 18 ft. 6 ins. deep, a very heavy and deep keel being used. The engines drive a four-bladed screw 9 ft. 8 ins. diameter.

A FLOATING DOCK is to be built at Havana, Cuba, and proposals for its construction and operation are being received by the firm of R. Z. Jimenez & Co., 44 Broad St., New York city. The dock will be of mild steel and will have a capacity of 12,000 metric tons.

DRY-DOCK NO. 2, AT THE BROOKLYN NAVY YARD, lately damaged by the lifting of the caisson gate during a change in the ballast, has now been emptied and is being cleaned out. The damage is said to be somewhat greater than was at first reported and a second session of the naval court of inquiry is being held. The rubber gasket from the caisson is an exhibit before the court, and it shows the enormous lifting strain put upon it by being torn in shreds in places.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was caused by the collapse of a bridge under a stock train near Baraboo, Wis., on the Chicago & Northwestern Ry., Sept. 20. The bridge was under repair at the time. The engineman was fatally injured.——A collision between a southbound passenger train and a train of empty flat cars occurred Sept. 20 at the switch for the Breaker Island spur, on the Delaware & Hudson R. R., near Troy, N. Y. Both engines were damaged and the fireman on the passenger engine was badly crushed by the tender, which telescoped the cab.

THE EXPLOSION OF A LOCOMOTIVE BOILER occurred Sept. 23 on the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Pekin, Ill. The engine was a very heavy freight engine, and was standing in the yard at the time. The fireman was fatally injured.

THE CAVING-IN OF A TRENCH on Fifth Ave., near 44th St., New York city, on Sept. 28, caused the death of one man and injuries to two others. The trench was for new water pipes, and is said not to have been sufficiently protected by sheeting, while a platform across the trench carried a steam boiler and derrick in the work.

AN EXPLOSION OF FURNACE GAS occurred at the Duquesne Steel Works, Pittsburg, Pa., Sept. 20, seriously burning and injuring two men.

THE COLLAPSE OF A FLAT BUILDING under construction at 1078 Madison Ave., New York city, on Sept. 26, has revealed a terribly reckless character of construction and disregard of the building laws, while it also appears to show that the Building Department has not a sufficient force of inspectors to properly supervise the building work in progress. The building was 25×85 ft. The walls of the first two stories had been erected, three tiers of beams had been laid and the workmen were engaged in building the walls for the third story, when, without the slightest warning, the entire rear of the structure collapsed, and the walls, timbers, scaffolds and men fell to the cellar. One man was killed and eight were injured. An inspection showed extremely faulty work. It is said that the foundations were insufficient and had settled and cracked before the building fell, while the walls were not of proper thickness and the bricks were badly laid in a mortar that did not adhere to them. The lintels were insufficient to properly carry the masonry, and the flues, instead of being lined with tile throughout were lined only at points open to inspection. The combination of bad foundations and superstructure resulted in the sudden collapse without warning. Mr. Constable, Superintendent of the Building Department, has stated that this year the department was allowed only $265,000 to conduct the supervision of over $80,000,000 worth of building investments. It has 4,200 jobs to look after at present, and but 57 inspectors. These men are paid from $1,100 to $1,200 per year, while a foreman on a job gets about $1,500 per year. The inspector of the district in which the fallen building was situated, stated that he had two districts to look after, containing 220 jobs, and, in addition to these, he was obliged to make from 20 to 22 special investigations each day, and report on them. He had been so busy with this special work that he had not been able to visit the Madison Ave. house at all.

AN INCREASE IN ZYMOTIC DISEASES traceable to polluted water supply is again agitating the people of Chicago. Within the last fortnight the chemical analyses of the water from the various supply tunnels has shown it to be in a dangerous condition from sewage pollution, and within the same time the reports of the health officer have shown a rapid and dangerous increase in typhoid fever, so great an increase, indeed, that the health officer seriously considered the closing of the public schools where lake water only is available to the pupils. A committee of the grand jury for Cook Co., Ill., has also recently presented a report to that body which condemns the city water supply as unfit for use. Naturally these conditions have raised considerable discussion in the daily press and under the direction of Mayor Swift the city officials are exerting themselves to find some remedy. At present the most approved plan is to extend all the water supply tunnels to points four miles from the shore, and it is announced that legislation to this end will be urged upon the City Council.

THE U. S. LIFE SAVING SERVICE, in its annual report for 1895, states that there are 251 life saving stations on the Atlantic, Gulf and Pacific coasts and the Great Lakes; 184 of these being on the Atlantic coast line. There is but one river station; at the Falls of the Ohio, at Louisville, Ky. During the year 675 disasters to vessels on these coasts were reported, involving property valued at $10,725,175. Of this property nine-tenths was saved by the life saving stations and salvage and wrecking companies working together. These disasters involved the lives of 5,823 persons, with only 26 lives actually lost. Of the 675 vessels in jeopardy 73 were lost. On the New Jersey coast, with 49 stations, about 1,000 persons were on board ships in danger and only one life was lost; and only $885,535 worth of property was lost out of the $2,000,000 worth in peril. The total net expenditure for the service in 1895 was $1,285,577.

THE ENGLISH TORPEDO BOAT "SPITFIRE," classed as a torpedo boat destroyer, has lately had her full-power speed trial of six runs over the measured mile. She is said to have made an average speed of 27¾ knots per hour in the six runs; and for the full 3-hour trial the mean speed was 27.46 knots, or about 31½ miles per hour. The contract speed was 27 knots at 4,000 HP.; but she developed 4,527 HP.

OF THE NEW TORPEDO BOATS lately bid for, two of the 30-knot boats have been awarded to the Bath Iron Works, of Maine, and the remaining one goes to the Union Iron Works, of San Francisco. Wolff & Zwicken, of Portland, Oregon, will build two 22½-knot boats; and of the 20-knot boats, Herreshoff will build three, the Columbian Iron Works, of Baltimore, will build two, and Hillman Brothers, of Philadelphia, will build one. These eleven boats cover the appropriation of $1,300,000 provided for that purpose. The above awards, as made by Commodore Hichborn, of the Construction Bureau, and Commodore Melville, of the Bureau of Steam Engineering, are yet to be approved by the Secretary of the Navy.

THE COAST DEFENSE MONITOR "PURITAN," for the U. S. navy, is completed, and will go into commission about Nov. 1. This is the last of the five modernized double-turreted ships of the Monitor type to be finished. The "Puritan" has two steel barbette turrets and is 289½ ft. long, 60 ft. beam, 18 ft. mean draft and has a displacement of 6,060 tons. Her engines are twin-screw horizontal compounds of 3,700 I-HP. Her speed is 12.4 knots and she carries 410 tons of coal. Her main battery includes four 12-in. breech-loading rifles and six 4-in. rapid-fire guns; in her secondary battery are six 6-pdr. rapid-fire guns, two 37 mm. Hotchkiss and four Gatling guns. Her side armor is 14, 10 and 6 ins., with 8 ins. on the turrets and 14 ins. on the barbettes; the protective deck is 3 ins. thick. She was built by John Roach, of Chester, Pa., under the act of Congress of Mar. 3, 1885, but was completed at the New York navy yard. Her sister ships, the "Amphitrite," "Miantonomoh," "Monadnock," and "Terror" carry four 10-in. breech-loading rifles; though the "New Monterey," of a similar type, is armed with two 12-in. and two 10-in. breech-loading rifles.

SINKING A LARGE SUPPLY WELL FOR THE WATER-WORKS OF CANTON, MASS.

The accompanying illustration shows the method of sheet-piling and timbering used to sink a large well at Canton, Mass. The finished well is 40 ft. in diameter and 23 ft. deep, the wall being of hard burned Taunton brick laid in cement, and having a thickness of 20 ins. for the first 12 ft., of 16 ins. for 11 ft., or to the surface of the ground, and of 12 ins. for 3 ft. above ground. The wall rests on a granite foundation 3 ft. wide, the depth not being stated.

The site is within about 50 ft. of some springs. Three "soundings" indicated that gravel would be reached at 16 ft. from the surface, and it was intended to carry the well down 18 or 20 ft. deep. The gravel had such an inclination that it was deemed best to go down 20 ft. for the bottom of the well.

The contractor for the well was Mr. Geo. W. Mantle, of Boston, to whom we are indebted for the photograph from which the accompanying view was made. Mr. Robt. Bird was Chairman of the Board of Water Commissioners when the well was sunk, and kindly furnished us with a copy of the annual report of that body, containing a description of the well.

WELL UNDER CONSTRUCTION AT CANTON, MASS.
Mr. Geo. W. Mantle, Boston, Contractor.

In constructing the work Mr. Mantle first removed the muck from a space about 75 ft. square. Within this space he put down heavy timbers, forming two squares, one 50 and the other 30 ft. wide, on each side. Sheet-piling was then driven around the outside of the outer and the inside of the inner timbers, the latter having each of the corners cut off by additional timbering to form an octagon. Bracing was then employed, as shown in the view. The excavated material was lifted out in steel hods by means of a Cram's quick-acting steam derrick. Two centrifugal pumps, with a capacity of 900 gallons a minute, were employed to keep down the water during construction. The earth was removed in horizontal layers 4 ft. deep. After the wall was completed the central core was excavated.

The well is covered with a roof. Water comes in at the bottom and through openings in the brick wall just above the granite foundations.

ELECTRIC MINING IN THE ROCKY MOUNTAIN REGION.*

By Irving Hale, M. Am. Inst. M. E.**

The superiority of electric power for mining purposes was recognized in a general way as soon as the electric motor became a practical success, but it has required time and experience to amplify and fully develop its advantages and to overcome the minor difficulties that arose.

Advantages of Electric Power.

These may be considered under three heads, based on the nature of the generating power:

I. Electricity Generated by Water-Power.
(a) Saving of coal, water for steam (an important item in many places), firemen, handling ashes, boiler repairs.
(b) Electric motors, as now made, require less attendance and repairs than steam or compressed-air engines.
(c) Underground wires are more convenient than pipes
(d) Avoidance of losses by steam condensation underground.
(e) Avoidance of bad effects of steam underground—heating mine, vitiating air, rotting timbers.
(f) Electric motors are more efficient than the small steam and compressed-air engines used on hoists, pumps, diamond-drills, etc.
(g) Rotary motion of electric motor is superior to reciprocating motion of engine for many purposes, especially blowers and diamond-drills.
(h) Electric locomotives are peculiarly adapted to underground haulage where steam is impracticable.

II. Electricity Generated by Steam at Some Distant Point Where Fuel and Water are Cheaper.
(a) Saving of difference in cost of fuel and water between places where power is generated and used.
(b), (c), (d), (e), (f), (g), (h), same as under I.
(i) Superior economy of large compound and, where practicable, condensing engines, over the small, inefficient engines used on most mining machinery, proper allowance being made for losses in transforming and transmitting electric power.

III. Electricity Generated by Steam at Place Where Power is Used.
(a) Disappears.
(b), (c), (d), (e), (f), (g), (h), (i), same as under I. and II.

Counter-Considerations.

Against the advantages enumerated in the preceding section must be charged interest, insurance, taxes and depreciation on the excess of cost of water-power and electric plant over a steam plant for doing the same work; also the greater cost of attendance, if any, due to the location of machinery at two places, although this will in many cases be more than offset by the saving in attendance on motors as compared with steam engines and boilers.

Conditions Affecting the Cost of Plant.

The cost of an electric-transmission plant depends chiefly on three conditions:

First. Nature of water power (assuming such power to be used) and cost of developing it.

Second. Distance of transmission.

Third. Electromotive force or voltage used.

For a given power and electromotive force (which fixes the current) the cost of copper, for a specified percentage of line-loss, varies as the square of the distance.

For a given power and distance the cost of copper, for a specified percentage of line-loss, varies as the square of the distance.

For a given power and distance the cost of copper for a specified percentage of line-loss varies inversely as the square of the voltage.

If the voltage is increased in proportion to the distance, the cost of wire for transmitting a given power with a specified line-loss remains constant.

Table I. shows the cost of copper, at 14 cts. per lb., per K-W. transmitted by the two-wire system for various distances at different voltages, with 10% waste of energy in line.

Considering the fact that the total cost of steam or water power, electric generators, switch-board and motors seldom exceeds $150 per K-W., it is evident that when a distance is reached that makes the cost of wire and transformers, if used, exceed that amount, or the entire cost of the remainder of the plant, that distance may be considered to be near, if not beyond, the economical limit, unless the conditions are peculiarly favorable for electric power.

With 500 volts this condition is reached inside of three miles; with 1,000 volts, inside of six miles; with 5,000 volts, at about 17 miles, and with 10,000 volts, at about 50 miles (allowing for transformers). It is evident from the foregoing principles and figures that the key to long-distance transmission is high voltage.

Systems.

Direct Current.—Direct-current generators, suitable for power purposes cannot be made to operate successfully at a much higher electromotive force than 1,000 volts, on account of the arcing and short circuiting of the commutator and its connections required to rectify the current. The direct current cannot be transformed to a higher voltage, except in a machine similar in construction to a generator and open to the same objections.

Single-Phase Alternating Current.—The single-phase alternating-current generator can be wound without difficulty for 3,000 to 4,000 volts, and considerably higher if necessary, as the current is taken off from two continuous rings without rectifying it, thus avoiding the difficulties experienced with the commutators of the direct-current machine.

An alternating current of moderate voltage can be transformed into a current of smaller amperage and proportionally higher voltage, for transmission, and can be retransformed at the other end of the line to any voltage desired for lights or power, the amperage varying inversely as the voltage. The energy remains the same, excepting a small loss in the transformation, not exceeding 2% in large transformers. Many plants are in operation at 10,000 to 12,000 volts, and as high as 50,000 volts has been used experimentally with promising results.

The single-phase alternating current is widely used for lighting, but, being a simple alternating wave, is not suitable for power, as no satisfactory single-phase alternating motor of large size has yet been devised that is self-starting under load and capable of speed regulation.

Multiphase Alternating Current.—A multiphase generator has several windings, so placed as to generate several alternating currents differing in phase; that is, passing the zero and maximum points at different instants. Under the influence of these currents (which may be compared roughly to the cranks of a duplex or triplex engine—no dead-center), multiphase synchronous motors are self-starting under light load, while non-synchronous or induction motors will start under full load, and are capable of speed regulation. The latter possess the good qualities of direct-current motors, and the additional advantage of having no commutator and, unless speed regulation is required, neither collecting rings nor brushes, the wires being simply connected to terminals on the field of the machine. On the other hand, the multiphase alternating current, like the single phase, retains the indispensable quality, for long-distance transmission, of being transformable from low to high voltage for transmission, and from high to low for use at its destination.

In the large number of electric-mining plants installed in the Rocky Mountain district during the past eight years, the following systems have been tried:

Direct current, moderate voltage (500 volts or less).
Direct current, high voltage (900).
Direct current, using several generators and motors in series.
Single-phase alternating.
Two-phase alternating.
Three-phase alternating.

Table II. gives a list, which is believed to be complete and correct, of all electric-power plants for mining and ore-reducing purposes in this district, showing in detail the number, kind and capacity of the machines installed and the distance of transmission.

Electric Mining Machinery.

As will be seen from an examination of the appended list of plants, electricity is being applied to the operation of every kind of machinery used in mines.

TABLE I.—Cost of Copper (at 14 cts. per lb.) Required to Transmit 1 K-W. Various Distances with 10% Loss in Line.

Volts.	Miles. 1.	2.	3.	4.	5.	10.	15.	20.	30.	40.	50.
500	$20.00	$80.00	$180.00	$320.00	$500.00	$2,000.00	$4,500.00	$8,000.00	$18,000.00	$32,000.00	$50,000.00
1,000	5.00	20.00	45.00	80.00	125.00	500.00	1,125.00	2,000.00	4,500.00	8,000.00	12,500.00
2,000	1.25	5.00	11.25	20.00	31.25	125.00	281.25	500.00	1,125.00	2,000.00	3,125.00
3,000	.56	2.22	5.00	8.89	13.89	55.56	125.00	222.22	500.00	888.89	1,388.89
4,000	.31	1.25	2.81	5.00	7.88	31.25	70.31	125.00	281.00	500.00	781.25
5,000	.20	.80	1.80	3.20	5.00	20.00	45.00	80.00	180.00	320.00	500.00
10,000	.05	.20	.45	.80	1.25	5.00	11.25	20.00	45.00	80.00	125.00
15,000	.02	.09	.20	.35	.56	2.22	5.00	8.89	20.00	35.56	55.56
20,000	.01	.05	.11	.20	.31	1.25	2.81	5.00	11.25	20.00	31.25
30,000	...	.02	.05	.09	.16	.56	1.25	2.22	5.00	8.89	13.89
40,000	...	.01	.03	.05	.08	.31	.70	1.25	2.81	5.00	7.81
50,000	...	...	.02	.03	.05	.20	.45	.80	1.80	3.20	5.00

*Abstract of a paper read at the Colorado meeting of the American Institute of Mining Engineers, Sept., 1896.
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Hoists.—The first application of electric power, and one of the simplest, was to hoisting; the rotary motion of the electric motor being easily adapted to this work. Most of the earlier machines consisted of street-car motors, geared to flat-friction or V-friction hoists. This type is very satisfactory for small or medium-sized machines, as the friction-gear is an assistance to the motor-controller in smooth starting.

For large hoists a positive geared motor is more reliable; but it is desirable to interpose a friction-clutch or equivalent device at some point between armature and drum, as a safeguard in case of excessive strain on the gearing, caused by the inertia of the armature when the drum is stopped by a too sudden application of the brakes. Mr. D. W. Brunton, of Aspen, has designed a slipping-pinion, which is used on the electric hoists in mines under his management, and serves this purpose admirably.

The choice of the best kind of motor depends considerably on the size of the hoist, its location, and the nature of the work. For an unbalanced hoist of moderate size, especially if placed underground and exposed to dirt and water, the iron-clad series-wound street-car type is well adapted, as it is strong, well protected and designed to stand heavy work on intermittent service. In this motor, efficiency, low heating and absolute freedom from sparking are to some extent sacrificed for compactness and lightness. For large hoists, which are generally located in comparatively clean, dry places, and, if over-balanced, work almost continuously, hoisting and lowering, and in which high efficiency is more important than in small hoists, the stationary type of motor is usually preferable.

The speed-controller is one of the most important features of an electric hoist. On most hoists a variable resistance in armature-circuit is employed; and by making this resistance sufficiently high, a perfectly smooth start may be obtained, even with slack rope. The most satisfactory rheostatic controller, especially for heavy work, is one in which the resistance is cut in and out by a cylindrical switch with magnetic blow-out, which avoids the troublesome effect of arcing at contacts, when the current is broken. In some cases it is practicable to use a double-motor equipment, with series-parallel controller, such as is now employed almost exclusively in street-car work.

By overbalancing a hoist, making the counterweight equal to the dead load plus about half the live load, the work in hoisting and lowering can be made approximately equal, and the maximum current and size of motor can be reduced to considerably less than half of what would be required for doing the same work with an unbalanced hoist. This principle is used in the electric hoists at the Free Silver, Alta Argent and Della S. mines at Aspen, and the Silver Lake mines at Silverton, and will doubtless be employed more generally in the future than in the past.

The Alta Argent hoist, in addition to being overbalanced, is arranged in a novel manner. The hoist, with its motor, is placed on a substantial platform above the head of the incline, and is out of the way of the operator, who is located, with the controlling levers, just below the hoist and on the level where the cars are run off. This gives more room for handling the cars as they are raised, and enables the hoist-operator to do this work.

The largest electric hoist in the world is on the Free Silver shaft at Aspen, Colorado. It is an overbalanced double-reel, flat-rope hoist, equipped with a 100-K-W. 4-pole motor, capable of developing 120 HP. continuously and 150 to 175 HP. intermittently. An auxiliary 60-HP. motor, ordinarily doing other work, is arranged so that it can be geared to the hoist counter-shaft and assist the large motor if necessary. Each reel has 1,500 ft. of 4 × ⅝-in. flat rope, weighing 2¾ lbs. per ft. The cage weighs 1,375 lbs, bucket and ore (hung from cage in sinking) about 2,400 lbs., car and ore about 3,500 lbs., and bailer, containing 111 cu. ft. of water, about 9,000 lbs. Two counter-weights are used, the one for cage and bucket weighing 2,450 lbs., and the one for cage and car 2,675 lbs., the two being combined when bailing. Two armature-pinions are provided (the motor sliding on rails), one for ordinary hoisting giving a speed of 600 ft. per minute, and the other for bailing at 1,000 ft. per minute, which, with the maximum load of about 10,000 lbs. (bailing), would require over 300-HP. net, exclusive of friction in gearing and rope, were it not for the overbalanced arrangement. Actual tests have shown that the average current consumed in hoisting with the counter-weight is only about one-third of the amount required when the hoist is unbalanced.

Pumps.—The electric pump presents a somewhat more difficult mechanical problem than the hoist, on account of the conversion of rotary into reciprocating motion, and the importance, in most cases, of compactness and protection of the motor against water. That the problem has been satisfactorily solved, however, is proved by the large number of electric pumps of various kinds and sizes in successful operation.

Duplex and triplex pumps, both vertical and horizontal, are suitable for operation by electric motors. For small pumps, where plenty of space is available, a belted motor affords the cheapest arrangement and gives satisfactory results. In the majority of cases a geared pump with motor on the same base is best. Both spur and worm-gears have been used successfully, various devices being employed with the latter to neutralize the thrust. In the Virginius 70-HP. pump, the armature-shaft carries two worms, one right and one left-hand, working into two gears which mesh into each other. In the 15-HP. pump in the same mine, the armature is placed vertically, and its weight approximately offsets the thrust. In most of the electric pumps made during the past few years, spur-gearing has been used, and with good results.

The sinking-pump is the most difficult to design, on account of the small space available for the motor, and the necessity of enclosing it in a practically water-tight case; but numerous successful pumps of this kind have been made and installed. The three-phase induction-motor is especially adapted to this work, and it has no brushes or moving contacts, and the wires can be carried through water-tight bushings in the case to the stationary terminals on the field.

Speed-control is an important question in electric pumping. Where waste of power is unobjectionable, a rheostat in armature-circuit is suitable. If high efficiency is imperative, and the required variation in speed is not great, it may be economically accomplished by varying the field-strength of the motor, either by commutating a sectional field or by the use of a rheostat. When the generator supplies nothing but the pump, an excellent method is to vary the generator-voltage by changing its speed or field-strength, or both. In some cases a water by-pass can be advantageously used. In others it is best to pump at full capacity intermittently. The most suitable method is a matter of judgment in each case.

Blowers.—The running of blowers and exhausters is another simple operation, the motor being either belted, geared or direct-connected to the blower-shaft. Small outfits of this kind, placed at various points throughout the mine, run continuously with very little attention, and afford the most economical and satisfactory ventilation—far superior to the vitiated air that has passed through air compressors and drills.

Percussion-Drills.—To obtain with electricity the rapid reciprocating motion with varying stroke and necessary elasticity required in a percussion-drill, and at the same time get a machine that will stand unlimited abuse, has been the hardest problem in the mining field that the electrician has had to solve.

Two general methods have been followed. One employs the ordinary rotary motor, connected to the drill by a flexible shaft and producing the oscillatory motion by cranks, cams, levers, springs and similar devices. The other uses the solenoid principle, the plunger being moved back and forth within two solenoids, placed end to end, by currents sent through the two alternately, these currents being shifted automatically at the drill or generator—generally and preferably at the latter.

The solenoid type of drill is the only one that has been used commercially and successfully in this country. These drills were tried in several mines in Colorado and elsewhere about four years ago, but were only partially satisfactory. The principal defects were lack of pulling-power, heating of solenoids, unsoldering of connections and breaking of drill-chucks, due to the crystallization of the bronze of which they were at that time made. These defects have been remedied by better electrical and mechanical design of solenoids and connections, and the adoption of an all-steel plunger and chuck. The improved drills have been used successfully for some time in quarrying and tunneling in the East; and a few plants, as shown in the table, have recently been installed in mines in this vicinity, the operation of which will throw much light on the exact value of the drill for mining use.

Diamond Prospecting Drills.—In contrast with the percussion drill, the rotary diamond-drill is more easily and satisfactorily operated by an electric motor than by any other power, not only because the rotary motion of the motor can be applied directly to the drill, while the reciprocating motion of a steam or air-engine must be converted, but also because the former is much steadier than the latter, and causes less wear and breakage of carbons. Moreover, the transmission of power into a mine by electricity is more economical than by steam or air, and the electric drill, with its wires, can be more conveniently

TABLE II.—LIST OF ELECTRIC-POWER PLANTS FOR MINES, MILLS AND SMELTERS IN THE ROCKY MOUNTAIN REGION.

Abbreviations: DC., direct-current; SP., single-phase alternating current; 2P., two-phase alternating current; 3P., three-phase alternating current; Dr., special alternating drill current.
Note.—Percussion drills are classed, for convenience, as motors and nominally rated at 5 HP. each.

Location.	Name.	System.	Distance transmission in miles.	Voltage of generators.	Voltage of line.	Generator capacity in K.-W.	Total (motors.) No.	Total (motors.) HP.
Colorado.	Central Stations.							
Aspen	People's Light and Power Co.	DC.	..	500	500	400	..	..
	Roaring Fork Electric Light and Power Co.	DC.	3.5	500	500	545	..	..
	Mines and Mills.							
	Alta Argent Mine	DC.	..	500	500	...	2	25
	Aspen Mine	DC.	..	500	500	...	3	56
	Aspen Mining and Smelting Co.	DC.	1.5	500	500	80	7	69
	Bimetallic Mining Co.	DC.	0.5	500	500	15	2	5
	Bushwhacker Mine	DC.	..	500	500	...	2	11
	Della S. Mine	DC.	..	500	500	...	4	130
	Durant Mine	DC.	..	500	500	...	3	95
	Free Silver Shaft	DC.	..	500	500	...	3	183
	Lessees	DC.	..	500	500	...	2	6
	Mineral Farm Mine	DC.	..	500	500	...	3	11
	Smuggler Concentrator	DC.	..	500	500	...	1	110
	Taylor & Brunton Sampler	DC.	..	500	500	...	1	35
Central	Old Kentucky Mine [1]	Dr.	0.1	220	220	45	1	5
Creede	New York and Chance Mining Co.	DC.	2	500	500	100	2	84
Denver	Omaha & Grant Smelting Co.	DC.	0.1	500	500	100	4	86
Florence	Metallic Extraction Co.	DC.	0.8	500	500	55	1	30
Gilman	Gilman Electric Light and Power Co.	DC.	0.5	500	500	45	..	..
	Belden Mine	...	..	...	...	...	1	20
Leadville	Ibex Mining Co.	DC.	0.3	110	110	40	1	3
Manitou	Wilson & Jackson, Colo. Springs W.-W. Tunnel.	3P.	8	3,000	3,000	150	1	75
Ouray	Caroline Mining Co.[2]	DC.	4	900	900	600	11	514
	American Gold Mining Co.	DC.	2	500	500	60	3	90
Rouse	Colorado Fuel and Iron Co.	DC.	0.5	500	500	100[3]	6	300
San Bernardo[1]	San Bernardo Silver Mining Co.	DC.	0.5	250	250	6	1	5
Silverton	Silver Lake Mines	3P.	3	2,500	2,500	300[3]	8	326
Telluride	Central Station—Telluride P'r Transmission Co.	2P.[4]	15	500	10,000	1,500	..	..
	Supplying following:							
	Columbia-Menona Gold Mines Co.	....	..	...	...	...	3	120
	San Miguel Concentrating and Mining Co, Bear Creek Mill (at present)	....	..	...	...	...	4	80
	Turkey Creek Mill	....	..	...	...	...	2	50
	Smuggler Union Mining Co.	....	..	...	...	...	5	190
	Tomboy Gold Mines Co.	....	..	...	...	...	5	190
Tin Cup	Brunswick Mining and Milling Co.	DC.	0.3	250	250	9	1	8
Tomichi	Magna Charta Silver Mining and Tunnel Co.	DC.	0.4	500	500	90	..	..
	Lewiston Mine	DC.	0.4	500	500	...	3	56
Victor	Columbine-Victor Deep Mining and Tunnel Co.	Dr.	0.2	135	135	35	3	15
	Cripple Creek Gold Tunnel Co.	Dr.	0.1	135	135	12	2	10
	Golconda Gold Mining and Milling Co.	Dr.	0.1	135	135	12	2	10
Ward	Chicago & Colorado Mining and Milling Co.	3P.	0.8	440	440	75	2	25
Idaho.								
Burke	Consolidated Tiger & Poorman Mining Co.	DC.	1.5	1,200	1,200	350	2	450
Wardner	Bunker Hill & Sullivan Min'g & Concent'g Co.	DC.	0.3	500	500	25	2	30
Montana.								
Anaconda	Anaconda Cop. Min. Co. (Electrolytic Cop. Rfnry)	DC.	..	75	...	1,970	..	..
				110	...	...	2	40
Bannock	Gold Dredging Co.	DC.	..	500	500	100	4	130
Butte	Virginius Mine (Power from central station).	DC.	..	500	500	...	1	50
Corbin	Helena & Livingston Smelting & Reduction Co.	DC.	2	500	500	485	4	555
Great Falls	Boston & Montana Cons. Cop. & Silver M. Co.	DC.	Data unobtainable.					
Utah.								
Castle Gate	Pleasant Valley Coal Co.	DC.	1.3	500	500	248	4	190
Scofield	Pleasant Valley Coal Co.	DC.	1	500	500	124	3	135
Green River	Bennett Amalgamator Mfg. Co.[5]	DC.	..	500	500	100	4	78
Park City	Ontario Silver Mining Co.	3P.	6.5	2,500	2,500	150	4	70
Wyoming.								
Rock Springs	Union Pacific Coal Co.	DC.	2	500	500	62	1	60
	Total	....	..	...	...	7,988	135	4,816

[1](Trout Lake.) [2]Virginius Mine and Revenue Tunnel and Mill. [3]To be duplicated. [4]Formerly single phase. [5](For South Placer Mining Co.)

moved from place to place than the steam or air-drill and pipes. On account of these advantages the electric diamond-drill has become a favorite wherever current can be conveniently obtained.

Coal Cutters.—Electricity was successfully used for coal-cutting even when the direct-current motor was the only kind available. The application to the chain-cutter of the three-phase, induction motor, without commutator, collector or brushes, and avoiding all possibility of sparking, has produced an almost ideal machine for this work. Another valuable characteristic of the induction-motor for this kind of service is the fact that, when overloaded beyond a certain limit by striking a hard stratum or by sticking of the cutter, it stops, thus relieving both motor and machine from excessive strains. These coal-cutters are being rapidly introduced in the East, but have not yet been used in this part of the country.

Locomotives.—Electric haulage in mines, under ordinary conditions and where distance and tonnage are not too small, is without much question superior to any other system available. It is more flexible than rope-haulage and more economical than mules or compressed air.

Mine-haulage is similar in most respects to street-railway service; but the locomotives must generally be adapted to narrow gage, the motors should be better protected, the speed is slower and the weight on driving-wheels greater.

The series-parallel controller, now so widely used in street-car service, which throws the motors in series for starting and slow speeds, and in parallel for higher speeds, is not so suitable for a mining-locomotive, for the reason that the slipping of one pair of wheels (which is more liable to occur than on a street-car, the load being behind the locomotive and the rails being more slippery) increases the speed of the motor on that axle, raises the counter-electromotive force and cuts down the current through both motors, if in series, thus reducing the power of both. For this reason some form of rheostat-controller is generally used. The essential requirements in a mining-locomotive are compactness, strength, simplicity, convenience of handling and especially durability and freedom from repairs.

Placer-Mining Machines.—Electric power has been very satisfactorily applied to the operation of placer-mining machines, several motors being employed to run the different parts of the dredge and gravel-treating apparatus. One motor generally raises and lowers the dipper; one forces it into the bank; another works the turn-table for depositing the gravel in the hopper; and a fourth operates the cylinder, tailings-carrier, amalgamator, etc. All of these motors are supplied by a generator located at any convenient point. The peculiar adaptability of electric motors to such work is evident; in fact it would be difficult to operate such a machine in any other way.

The Bennett Amalgamator Manufacturing Co. is operating a plant of this kind for the South Park Mining Co. at Green River, Utah, and the Gold Dredging Co. has a similar installation at Bannock, Montana.

Electro-Metallurgy.

Copper-Refining.—The principal application of electricity to metallurgical operations in this part of the country is copper-refining, which is carried on extensively at Anaconda and Great Falls, Montana. The plant at Anaconda consists of eight electrolytic generators, aggregating 1,870 K-W., and its capacity is 125 tons of refined copper per day, the average output being about 100 tons per day. They also have a 100-K-W., 110-volt power generator, supplying two 25 HP. locomotives and three traveling cranes, for handling and transporting materials and product.

The commercial success of this process is too well established to require discussion. Its economy is principally a question of the cost of power and the scale on which operations can be conducted.

Gold and Silver Extraction.—Electricity has been applied as an auxiliary in various processes for the treatment of gold and silver ores by cyanide, chlorination and amalgamation. While some of these processes are based solely on the faith of the inventor that a current of electricity sent through his mixture will in some mysterious way produce results that he cannot otherwise obtain, others undoubtedly possess merit, as they are founded on well-established laws of electro-chemical action. These processes are usually conducted with considerable secrecy, and it is impossible to give any reliable data as to the actual results accomplished or the economy of the operations. There is reason to believe, however, that, with the proper combination of chemical, metallurgical and electrical knowledge brought to bear upon this subject, good results may be expected.

Future Development.

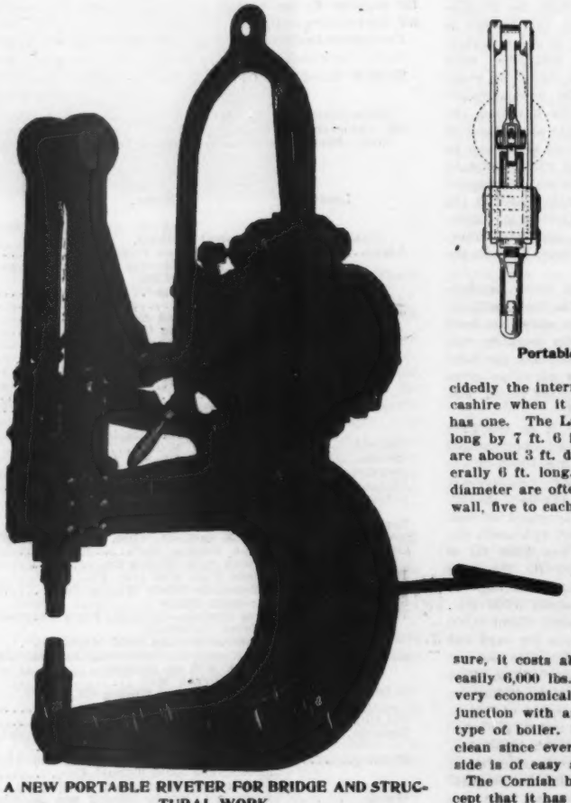
During the past eight years and principally in the last four years, 52 distinct companies in the Rocky Mountain district alone have installed electric-power machinery for mining and ore-reducing purposes, comprising 62 generators, aggregating 7,988 K-W., and 135 motors, aggregating 4,816 HP., operating every variety of mining and milling machinery.

Electric apparatus, formerly regarded as delicate and peculiarly subject to break-downs, has been brought to such a degree of perfection that depreciation and repairs may be considered as less on this than on almost any other kind of machinery.

The multiphase high-voltage system has brought nearly every mining district within economical reach of water-power. The induction-motor, without commutator, collector or brushes, is the acme of simplicity and durability. Electro-metallurgical operations are increasing and give promise of success. Under these conditions it may be safely predicted that during the next five years much greater progress will be made, and the application of electricity will become one of the most attractive and important features of mining economy.

SOME NEW DESIGNS IN POWER RIVETING MACHINERY.

The half-tone cut herewith shows a new form of bridge riveter recently placed on the market by Mr. Chester B. Albree, of Allegheny, Pa. The peculiar feature of this riveter is the means by which the power is transmitted from the air cylinder to the ram. On top of the ram is a roller, on which rests the inclined arm or lever shown in the cut, which is pressed down by the roller at the end of the link to which is connected the pitman or connecting rod, driven by the trunk piston. A toggle joint motion is thus secured, which gives the greatest pressure at the extreme end of the stroke. The yoke of the riveter is of cast steel, of 60,000 lbs. tensile strength. The working parts are of hardened steel. The cylinder is provided with an automatic cushioning device and the valve is perfectly balanced. The machine will balance either horizontally or vertically by the trunnions. The yokes are made of different depths



A NEW PORTABLE RIVETER FOR BRIDGE AND STRUCTURAL WORK.

Designed and Built by Chester B. Albree, Allegheny, Pa.

to suit different classes of work, 26-in., 36-in., 60-in. and 70-in. The cylinders are made either 10 ins. or 14 ins. diameter, as ordered. Mr. Albree has also patented an ingenious column riveter for work in contracted spaces where the ordinary power riveter cannot be used or is used only with difficulty. The accompanying cut shows its mechanism.

Either of the above machines are built to operate with compressed air; but can be built for steam or hydraulic pressure where desired. Stationary riveters for heavy work in boiler and tank shops are also built with operating mechanism, similar to that shown on the other machines. The durability of these machines has been tested by their use for some nine months in the structural iron works of Mr. Albree, where it has given the best of satisfaction.

STEAM BOILER PRACTICE IN EUROPE.

Circular No. 5 of the Steam Users' Association, Edward Atkinson, president, contains the report of Mr. R. S. Hale of his visit to Europe to study European boiler practice. The following table, prepared by Mr. Hiller, of the National Boiler Insurance Co. of Manchester, is given in the report:

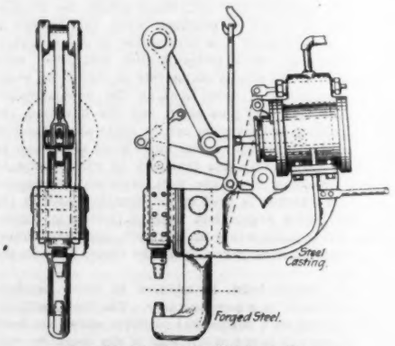
Per Cent. of Boilers of Various Types Used in Europe.

	United Kingdom.	France.	Germany.	Switzerland.	Austria.
Year	1895.	1893-4			
Lancashire & similar types.	38.0	4.7	35.7	19.6	*
Cornish and similar types.	23.7	8.2	15.3	40.8	*
Extern'ly fired cylindrical[1]	6.8	57.3	14.8	15.5	41.0
" " multitubul'r	..	13.4	5.2	5.5	7.5
Locomotive	11.0	5.1	17.3	5.7	10.5
Small verticals	16.0	3.6	5.0	13.5	6.1
Water tubes	1.8	5.7	4.6	1.4	3.8
Other types	2.1	2.0	2.1	..	1.4
Total	100.0	100.0	100.0	100.0	100.0

*Lancashire, Cornish and similar types, 29.7. [1]Including elephant.

From Mr. Hale's comments on the several styles of boiler used we extract the following:

The standard type of boiler, with the exception of France and the Province of Elsass in Germany, was decidedly the internally fired flue boiler known as the Lancashire when it has two flues, and the Cornish when it has one. The Lancashire boiler is generally about 30 ft. long by 7 ft. 6 ins. in diameter. The two internal flues are about 3 ft. diameter, and the grates in them are generally 6 ft. long. Galloway, or cross tubes, about 6 ins. diameter are often placed in the tubes back of the bridge wall, five to each flue, but this is advised against by some of the best authorities. The gases after leaving the furnace tubes pass underneath the boiler to the front, then back along the sides to the underground flue. Such a boiler would have 36 sq. ft. of grate surface and about 1,000 sq. ft. of heating surface, giving a surface ratio of 28. When built for 160 lbs. steam pressure, it costs about $2,500 in England, and will deliver easily 6,000 lbs. steam per hour. At this rate it is not very economical, but if used at a lower rate or in conjunction with an economizer it is as economical as any type of boiler. It is a boiler that is very easy to keep clean since every portion of the surface inside and outside is of easy access.



Portable Riveter for Work on Columns.

The Cornish boiler is exactly like the Lancashire, except that it has only one furnace tube. This single tube is in England placed in the center, in Germany it is placed to one side with the idea of improving the circulation. It is nowadays rarely built except for small plants, so that the average Cornish boiler is probably considered older than the average Lancashire.

In France and in Elsass, Germany, the type of boiler known as the "elephant" is the standard. This is classed under the head of externally fired cylindrical in Mr. Hiller's table. It is not as regular in size or proportion as the Lancashire. The upper shell is generally from 20 to 30 ft. long and some 5 ft. in diameter. The two lower shells called "bouilleurs" are about 2 ft. diameter. They have one and sometimes two connections to the main shell. This boiler has the advantage of allowing a very large grate surface, an important consideration with the poor coals in use on the Continent.

In boiler construction I judged the English workman-

ship to be fully equal to our best. In England no punching is allowed; the plates are always planed on the edges and then drilled in place. Steel is being used almost exclusively in England; iron is still preferred in some places on the Continent.

The internal flues in the Lancashire boilers are generally welded along the longitudinal seam, and the cross or Galloway tubes are frequently welded in. I did not hear of any cases of welding the boiler-shell itself. The flues are occasionally made corrugated in various ways as the Fox, Purves, and other patents. My impression was that these were considered better, but that most frequently the improvement did not warrant the expense. The steam pressures, of course, varied from plant to plant. I should judge that if 140 to 150 lbs. was considered a standard for a new mill in America, the corresponding practice would be 200 lbs. in England, 180 in Elsass, and 140 to 150 in Belgium and Germany. In all countries I found occasionally higher pressures than the above, and, of course, the immense majority were lower.

Economizers.

The use of economizers is more general in Europe than in America, and the type known as the "Green," now made by several good firms, is the standard. Occasionally on the Continent one of the bouilleurs of the elephant boiler was used as an economizer. The most general practice was to put one economizer for each battery of boilers, making the economizer heating surface and the boiler heating surface the same. In Belgium, however, they were recommending one small economizer to each boiler. Scrapers are used to keep the fire surfaces clear of soot. The water surfaces are subject to scaling if the water be bad, and it is chiefly in the bad water districts that economizers are not used, though they are not much if any, worse in this respect than water tube boilers. But when the economizers are taken out the heating surface of the boilers must be more than doubled to get the same economy.

Heat Storage.

An advantage claimed for the Lancashire boilers and for the economizers was that the large amount of hot water in them afforded a reserve of heat for a sudden call. An interesting application of this principle were the feed tor-age and the steam storage systems of D. Halpin, Esq., London. The first is applicable to all plants and consists in providing tanks in which the feed is heated to the steam temperature by steam from the boiler during light demand, so that during the heavy demand the feed water is supplied hot (380° F.) instead of 100° or 200°. The steam storage consists in having very high pressure boilers, which pressure is reduced at the engine. Water is heated to boiler pressure during light load and stored in tanks, and during the heavy load expands into steam and relieves the demand of the engines on the boilers proper. The steam storage system did not impress the writer favorably. If you are going to go to the expense of high pressure boilers anyway, then it seems to him that you will be as apt to save coal by using high pressure steam at your engines as by reducing the pressure in order to equalize the load on the boilers. But the feed storage system, particularly where economizers are not used, seems a very practicable method of reducing the net first cost by a few per cent. (the boiler plant saved would cost more than the feed storage), and at the same time probably increasing the economy. Both the feed and steam storage systems are especially available with bad water.

Superheaters.

The use of superheated steam is very much in the air all over Europe, and in Elsass (Alsace) it is fairly general, about 500 superheaters being in use. There has never been any doubt that it saved from 10 to 20% of coal, but the difficulty has been in the lubrication of the engine cylinder and the keeping the large number of superheater joints tight. The Schwoerer superheater, which is much used in Elsass, consists of a small number of very heavy ribbed cast-iron pipes placed in a very hot portion of the flue, as, for instance, between the tubes and the drum of a Babcock & Wilcox boiler. The cast iron is made thick enough so that it may become red-hot without injury, and by being in the hot portion of the flue only a small superheater is required. The trouble with lubrication is overcome by using a high grade mineral oil. In England and on the Continent, several forms of superheaters using thin steel pipes were under test. I did not hear of their sale in any number as yet. The superheaters are also placed above a separately fired furnace in some plants.

Grates.

The grates in ordinary use did not noticeably differ from those in use in America. In Germany some of the under-fired boilers were provided with grates that inclined downwards to the rear as much as a foot or a foot and a half, which was thought to be easier for the firemen and to give better combustion. The ash-pits of these boilers were unusually deep. The coal is frequently very soft and bituminous, but in their internally fired boilers they had no trouble from having the furnace top only 18 ins. or less from the grates, in fact the Lancashire boiler enjoyed a better reputation for smokelessness than many others.

Mechanical Stokers.

In England several forms of mechanical stokers were in use, perhaps over one-quarter of the boilers being equipped. They may be divided into two general classes, the coking and the sprinkling stokers. The coking stokers feed the coal at the front where it cokes and is then carried to the rear by the reciprocating motion of the grate bars. The Vicars stoker is the best known of the class. It is represented in this country by the Roney, Wilkinson, Murphy, Brightman and other types; the chief difference being that on account of the internally fired boilers the Vicars grate bars are level. The sprinkling stokers throw the coal over the grates by means of revolving or oscillating shovels; but they generally use as well a reciprocating motion of the grate bars to carry the ashes to the back end. The Bennis stoker is perhaps the most widely used of this class, but there are several good firms who make stokers of each class.

Opinion is, of course, widely divided on the merits of mechanical stokers. What seemed to the writer to be the general drift of opinion of those best fitted to judge, was as follows: No stoker absolutely prevented smoke, but both types very largely diminished it. In this respect the coking stoker had a decided advantage over the sprinkling. Neither stoker kept up the steam pressure on a sudden call as well as hand firing; in this respect the sprinkling stoker was considered to act more quickly than the coking.

The sprinkling stoker was being sold at about three-quarters the price of the coking. The cost of the Vicars stoker was about $500 for two stokers, each 2 ft. 9 ins. or 3 ft. wide and 4 or 5 ft. long.

The opinion as to whether the stokers saved coal was evenly divided. The most general reasons for their adoption were the diminution of smoke, the smoke laws being very strict in England, and the use of a cheaper fuel. The use of a cheaper fuel undoubtedly saved money, but when compared on the same grade of fuel the best opinion, so far as the writer could judge, was that they saved some coal, but not enough to show a net saving after paying the interest and repairs. The saving in labor was not generally considered and did not amount to very much in small plants, or in plants where no coal handling devices were adopted. The use of stokers and coal handling appliances together was thought to save about one-third of the boiler room labor in large plants.

Dust Firing.

In Germany grinding the coal to a powder and blowing this dust coal mixed with air into a hot combustion chamber was a method that was being experimented on in several plants and was meeting with considerable favor. The "Wegener" process is used in England; the "Camp," the "Schwartzkopf," and others in Germany. Fig. 10 shows one of these arrangements. The fine dust (almost as fine as flour) is, however, not only a very dirty stuff to handle but is also exceedingly liable to spontaneous combustion, and the problem of grinding and storing it had not yet been commercially solved so far as the observation of the writer went.

Boiler Fittings.

In boiler fittings several differences were noted. All fittings were noticeably heavier and stronger than with us. The use of spring-loaded safety valves is looked on as yet with a great deal of distrust, and those in most common use are the lever valve and also the dead-weight valve.

The use of try-cocks has been entirely given up in every plant that I visited and two gage-glasses are used instead, having been found not only neater but safer. On the Continent one glass and a mechanical lever indicator were sometimes used.

The dampers on the smoke flues are almost always of the sliding and not of the butterfly type. This may be because the flues are almost always underground. The dampers are always regulated by hand, damper regulators being practically unknown. Forced, induced, steam-jet, and other artificial drafts are no more and no less in use than with us; that is they are not infrequent in special cases where the ordinary draft is insufficient, but they are in no sense general.

The use of guards on the water-gages is very common to prevent pieces of broken glass from injuring the fireman. This is peculiarly necessary since in most of the foreign boilers the water glasses are on a level with the fireman's face.

Pipe Covering.

The average quality of the boiler and pipe coverings did not seem to the writer as good as those in general use in this country. Occasionally he saw wood and even rope covering on high pressure piping, some of which was already distinctly charred. Some plants, of course, had very good coverings, and there was a custom of covering the top of the boilers very thickly with some cheap covering with the result that nine times out of ten the space over the boilers was noticeably cooler than it is in America.

Chimneys.

In regard to chimneys the variety of sizes and of theories is just as great as it is here. The few of which the writer obtained both the dimensions and the amount of coal they were intended to burn were larger than those given in the tables in American books of reference for the same capacity. This may be because in England they lay a good deal of stress on a good draft as an aid in smoke prevention, and the English laws are very strict as to smoke. Brick is almost universal, iron stacks being used only in very exceptional cases.

Boiler Operation.

The admission of air above the fire either at the door or at the bridge was used occasionally. The opinion was very general that this diminished smoke. As to economy of coal, authorities were divided, but the general drift was, that this admission of air resulted in a slight loss.

Boiler surfaces seem to be kept cleaner than is the general practice here. In some places they run the boilers until the specific gravity of the water is 1.005, then they blow out and clean the boiler. In England they use soda, lime and potash in the boilers, according to the impurities, and on the Continent they are also beginning to know about the advantages of kerosene. Purifying plants to take the impurities out before the water enters the boiler are not infrequent but are hardly considered a complete commercial success as yet. A little water is generally blown out once or twice a day just as with us, and in mills the fires are banked at night. In electric stations the custom was very general to let the fires go out when they were not needed. Several plants gave us the result of experiments on the cost of banking fires. Reducing these to 24-hour days and to equal grate areas they run about 40 lbs. per 24 hours per square foot of grate.

The opinion as to the practice of letting the steam pressure off the pipes when the load was off was divided. On the whole it was in favor of the practice, although some plants said they had tried it and had found the cost of repairs to more than balance the saving in coal.

Boiler Testing.

Boiler testing is in some respects more advanced than it is with us, chiefly in that they attempt to tell where all the heat supplied goes to and thus to determine the reasons of good or bad performances.

The bomb calorimeter, in one or the other of its various forms, Mahler, Donkin, etc., is considered the only accurate means of determining the heat value of a coal, though the method of analyzing coal and using one of the numerous modifications of Dulong's formula is quite often employed. The Thompson and other calorimeters of that type are not considered in the least available for practical work. It was the custom to correct the results of the calorimeter for the latent heat of the H_2O formed from the hydrogen in the coal, or, if using the formula, to assume that the hydrogen was burned to steam and not to water. Coal tests are, of course, compared on the evaporation per pound of coal, boiler tests were generally compared on the evaporation per pound of coal "pure and dry," dry referring, of course, to the moisture correction, pure to a correction of the earthy matter contained in the coal, but not allowing any correction for the unburned coal in the ashes. Occasionally, however, pure and dry meant exactly the same as our "combustible." In determining moisture in steam they are as far behind us in their general practice, with the exception of a few of their best engineers, as they are ahead of us in the analysis of the gases. Fortunately at the high steam pressure now in vogue the priming is generally a negligible quantity so that their results have not been affected.

Boiler Economy.

In boiler economy I could not see that they were either ahead or behind us; they get from 60% to 80% of the heat in the coal, according to the air supply and evaporation per square foot of heating surface. None of their engineers had ever found any combustible gases in the chimney, except occasionally a little carbonic oxide. Most of their tests, however, left some zero to 15% of the heat unaccounted for, which may be radiation or error. Some said one, some said the other. No one had experimented as to why it is harder to supply the right amount of air to one kind of coal than to another, though they had all gone as far as to realize the immense importance of the air supply, as compared with any other factor in boiler economy, and also to realize and to experiment on the amount of air that leaks through the settings of some types of boilers to the injury of economy. Frequently more air has been found to leak through the settings than came through the fire. In some plants on the Continent they were painting the brick settings with a heavy tar paint to make them air tight, and occasionally even enclosing them in sheet-iron casings.

THE REVOLVING TOWER, proposed by M. Devic as the feature of the Paris Exposition of 1900, will be only about half as high as the Eiffel tower, or about 500 ft. But it is proposed to make this tower revolve at the rate of about 2½ miles per hour, for any point on its outer wall. The revolving part would be about 80 ft. in diameter and would be fitted up with restaurants, shops, etc., with a public ball-room at the top.

AN EXPERIMENT IN DREDGING WITH DYNAMITE.

Dredging by dynamite has been carried on at the outer bar at Brunswick, Ga., for several years, by Mr. C. P. Goodyear, a lawyer of Brunswick. He began work in the summer of 1891, and expended about $8,000, with, it is claimed, beneficial results. In 1892 he secured an appropriation in the River and Harbor bill providing for compensation in case he secured a certain depth by Jan. 1, 1893. Three surveys were made by the Government engineers, none of which showed the increased depth of water which the act specified. In the River and Harbor act of 1893 the time for securing the increased depths was extended to Nov. 1, 1895, and by the act of next year $30,000 was awarded him for the work done, as shown by the testimony of the masters of vessels passing over the bar, although the surveys of the corps of engineers still showed that the contract depths had not been secured. The same act also appropriated $30,000 additional to be paid Mr. Goodyear if he should secure a minimum depth of 23 ft. in a channel 100 ft. wide across the bar by Nov. 1, 1895. A board consisting of W. W. Duffield, Superintendent of the Coast and Geodetic Survey; Major W. S. Stanton and Capt. F. V. Abbott, Corps of Engineers, U. S. A., was constituted to make surveys to determine whether this depth was obtained. Three surveys were made by this board in 1895, none of which showed that the increased depth had been secured.

Mr. Goodyear again went to Congress, therefore, and by the last River and Harbor bill he is to receive $70,000 when he obtains a channel 100 ft. wide and 24 ft. in depth across the bar; $30,000 additional when he secures a channel 200 ft. in width, with a least minimum depth of 23 ft., and $40,000 additional when a 200 ft. channel with a least depth of 24 ft. is secured. The surveys to determine this increased depth are to be made by an officer of the Coast and Geodetic Survey to be detailed by the Secretary of War. The work must all be done by June, 1899.

As we understand the matter, Congress, in this latest act, appears to have acted with considerable shrewdness. It refused to give the contractor anything for the 23 ft. channel 100 ft. wide, which was originally contracted for, as the soundings made by the board and by the engineer employed by Mr. Goodyear showed that the depth of the channel was already so close to 23 ft. that this depth might easily be brought about by the natural scour on the bar regardless of any work done, and whether it was secured or not was a matter on which engineers might easily disagree. To secure a depth of 24 ft., however, it seems probable that some real excavation will have to be done by the contractor; and if this depth is actually secured by his efforts, he will doubtless be entitled to compensation.

Respecting the actual merits of Mr. Goodyear's method of deepening channels by dynamite explosions, we are able to find nothing conclusive in its favor. He informs us in a personal letter that he has exploded over 200,000 lbs. of high-grade dynamite upon the bar, in charges from 25 lbs. to 200 lbs. The Board of Engineers in its report dated Jan. 11, 1896, stated that the best practicable channel 100 ft. wide across the bar was obstructed by about 9,000 cu. yds. less material in December, 1895, than in March, 1894, and about 21,000 cu. yds. had also been displaced from areas about 200 ft. wide at the side of this channel; but it says that there is no possible means of ascertaining how much of this was due to natural agencies and how much to Mr. Goodyear's dynamite explosions. On the other hand Mr. H. C. Ripley, an engineer employed by Mr. Goodyear, claims that the latter's operations had resulted in the removal of 785,000 cu. yds. of material in April last.

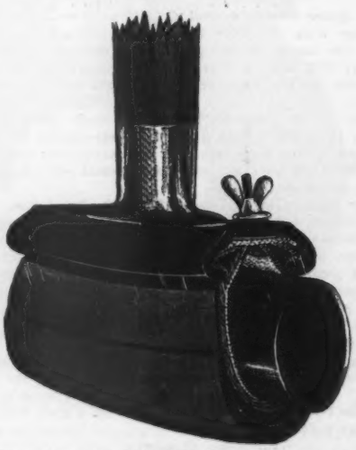
In view of the fact that prior to the wreck of a vessel upon the bar in 1879, there was an excellent channel across it nearly 23 ft. in depth and 900 ft. in width, it seems exceedingly probable that natural agencies are gradually restoring this former condition and that this has more to do with the improvement of the depth across the bar than Mr. Goodyear's dynamite explosions. He informs us that he has expended $133,500 upon this work to date. It appears to us that if he had expended this amount in work with modern dredging machinery, he would have removed a greater amount of material from the bar than even his own engineer claims and would have secured far more beneficial results.

PNEUMATIC VS. IRON TIRES FOR VEHICLES.

In "Le Genie Civil," for Aug. 15, 1896, Mr. Gerard Lavergne devotes considerable space to the application of pneumatic tires to the wheels of

Pneumatic Tire for Paris Cabs; Bicycle Wheel.

vehicles, a practice now quite common with the cabs of Paris. He says that an English engineer, Mr. R. W. Thomson, applied pneumatic tires to the wheels of carriages in 1846, and his device is fully described in "The Mechanics' Magazine" for August, 1846, and April and May, 1847. He at first employed an air chamber of rubber and an exterior envelope of leather; but he later used an air chamber made of canvas and rubber, reinforced by rubber on the rolling side, and very similar to the rubber tire of the present day. On March 17, 1847, Thomson made some experiments



Pneumatic Tire for Paris Cabs; Wooden Spoke Wheel.

upon relative traction efforts, in Regent's Park, and reported as follows:

	Ordinary wheels, lbs.	Pneumatic tires, lbs.
Over a good surface	45	28
Road covered with newly broken stone.	120	38½

According to these figures the economy in traction, due to the pneumatic tire, was about 38% on a good road and 68% over freshly broken stone. It should be said, however, that his dynamometer was crude and the results were merely approximate, useful only for their relative values.

As giving more reliable data, the writer makes an abstract from a paper recently presented to the Society of Civil Engineers by Mr. Michelin, recording some more carefully made experiments of this character. Mr. Michelin used for his registering apparatus a dynametric spring, formed by two articulated plates at one end of the apparatus; one fixed to the vehicle and the other to the whiffletree. With this was used an automatic registering device of somewhat complicated and delicate design.

The first experiments were made with iron and pneumatic tires of the following diameters and weights:

Kind.	Diameter of wheels, Front, ft.	Diameter of wheels, Back, ft.	Weight of wheels, Front, lbs.	Weight of wheels, Back, lbs.	Empty vehicle, lbs.
Iron tires	3.02	3.67	127.6	158.4	1,288.4
Pneumatic tires	2.95	3.93	85.8	123.2	1,192.4

To the weight of the empty vehicle the weight of the driver must be added; and to make this feature comparable the same driver was used in both cases. These experiments were made over various soils, over different lengths of road, with varying loads and at different speeds. The results of the trials made in January, August and September of 1895 and January and February of 1896 are summed up in the following table:

	Tires—Iron, lbs.	Tires—Pneumatic, lbs.
Experiments in Snow.		
Carriage at a walk, empty	34.80	25.23
Carriage at a walk, load of 330 lbs.	39.22	27.96
Carriage at a trot, load of 330 lbs.	65.12	33.59
Carriage at a trot, load of 660 lbs.	68.57	39.51
Experiments in Mud.		
Carriage at a walk, empty	35.20	23.10
Carriage at a walk, load of 330 lbs.	38.06	27.34
Carriage at a trot, load of 330 lbs.	43.01	28.53
Carriage at a trot, load of 660 lbs.	50.73	31.15
Mean of Trials upon Macadam; dry, new, dusty and well-paved, with grades varying from 1.2 to 5.8%		
Carriage at a walk, empty	38.32	30.91
Carriage at a trot, empty	44.90	35.09
Carriage at a walk, load of 660 lbs.	45.65	35.51
Carriage at a trot, load of 660 lbs.	65.34	36.08

These figures show that under all the conditions given the use of the pneumatic tire diminishes the tractive effort; and this economy is greater upon a bad than upon a good road, as was to be expected, and it also increases with the speed and the load.

Some experiments were made to compare the relative effect of iron tires and pneumatic tires with varying air-pressure and with plain rubber. The results were as follows:

Vehicle.	Iron tire.	Pneumatic—Air 6.6lbs.	Pneumatic—Pressure. 9.9lbs.	Plain rubber.
At a trot, load 660 lbs.	44.22	44.75	43.91	56.52
At a walk, empty	33.64	36.03	34.34	37.62
At a trot, empty	46.64	33.99	41.69	44.15
At a walk, load 660 lbs.	44.22	44.75	43.91	56.52
At a trot, load 660 lbs.	64.20	45.14	50.64	63.96
Average	47.17	39.97	42.65	50.31

From this table it would seem that the full rubber tire, while better than iron at a trot, is not so good at a walk. But Mr. Michelin adds that if the surface is muddy, or covered with snow, so as to remove all elements of elasticity, the full rubber tire gives better results than an iron tire. But the full rubber is always inferior in this respect to the pneumatic tire; and for the latter it would appear that the pressure of inflation should not exceed 6.6 lbs. The general mean of the experiments of Mr. Michelin in traction would give the following relative values:

Pneumatic tires	100.0
Full rubber tires	129.8
Iron tires	132.7

The author of the paper concludes with an illustrated description of some of the pneumatic tires used on vehicles in Paris, now generally fitted with metal rods, or spokes, though they can also be applied to wooden wheels. In the latter case the rim of the pneumatic is applied upon the wooden rim holding the spokes; but a better method is to fit upon the ends of the spokes a metal socket, which is riveted directly to the metal rim of the pneumatic.

The metal wheels are of the bicycle type, as shown in the cut, and need little description.

TRESTLE FOR CARRYING A FLUME AT SALTVILLE, VA.

By Emile Low, M. Am. Soc. C. E.

Occasion having arisen to convey away the liquid lime refuse of the Mathieson Alkali Works, with which the author has been connected as engineer, a plan was formulated, of which a flume trestle formed an integral part. Trestles for supporting flumes used in conveying water for irrigation purposes are common enough in the western states and territories, but in looking over the literature on hand on this subject, none was found which might serve as a precedent, and the author was compelled to evolve such a structure as would suit the exigency of the case in hand. As what might be termed in this particular, the rolling load, was comparatively a very light one, the

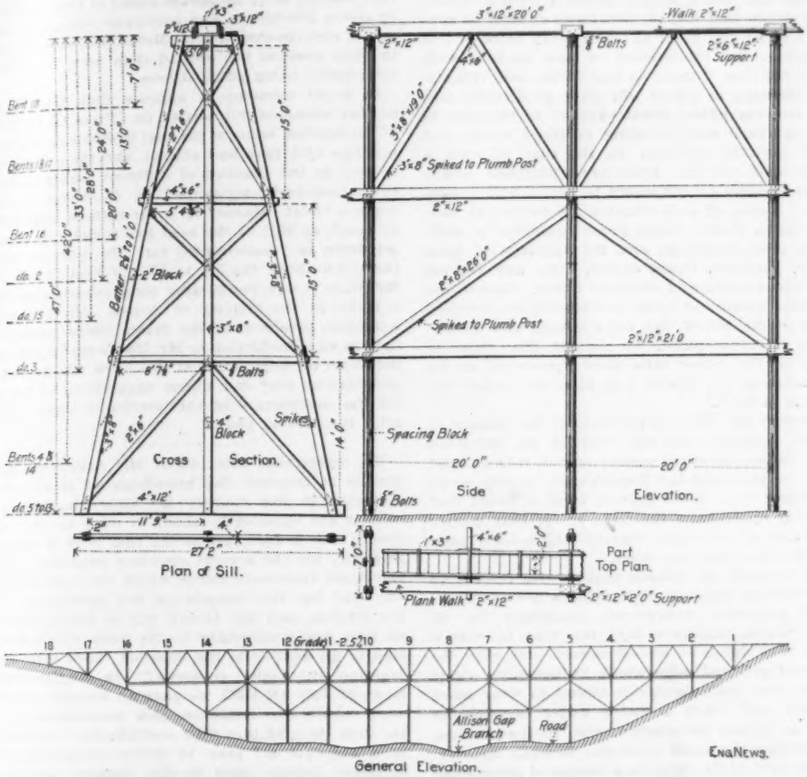


FIG. 1.—DETAILS OF TRESTLE AT MATHIESON ALKALI WORKS, SALTVILLE, VA.
Emile Low, Chief Engineer.

main essential was to design a structure as light as possible, and at the same time possessing the requisite stiffness for stability, etc.

After considering various designs, sizes of timber, length of spans, etc., the accompanying plan, Fig. 1, was finally selected.

The structure as built is 380 ft. long, the central portion being 47 ft. high, for 120 ft. in length. The grade employed is 2.5%. The spans are all 20 ft., measured center to center of bents. The foundations are mudsills, short timbers ranging from 6 to 12 ins. in thickness. Between the bents, where the creek flowed, the foundations were reinforced by rip-rap, to prevent washing and undermining. All the trestle legs were made of 3×8-in. stuff, arranged double, and separated by spacing blocks.

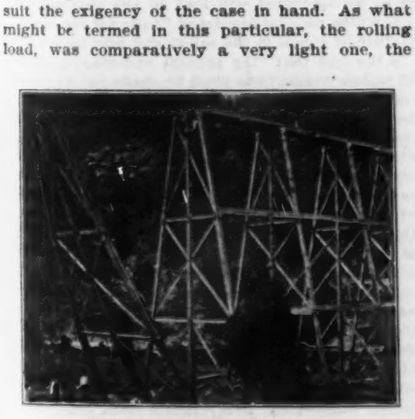


Fig. 2.—Trestle in Process of Erection, Showing Raising of a Bent.

It will be observed that the spacing blocks for the two batter legs are 2 ins. thick, while those of the vertical legs are 4 ins. thick, this so as to allow room for the double 2×6-in. braces, which cross each other at the vertical legs.

In ordering the timber it was in such lengths that bents Nos. 1 to 4, inclusive, and Nos 15 to 18, inclusive, were framed in one length. In bents Nos. 5 to 14, inclusive, the timber for each leg was ordered in two short and two long lengths, these pieces alternating on opposite sides, so that the splice always came near the middle of the long lengths, the joints abutting and being secured by three bolts, of which two passed through the braces, and one through the intermediate cap. This latter is 4×6 ins. in size and is dapped 1 in. on each side, at the ends, making the space between the parallel faces of the batter legs 2 ins., corresponding to the thickness of the braces and spacing blocks.

The sills and caps are made of 4×12-in. pieces, to secure vertical stiffness. The framing of these is similar to that of the intermediate caps, and is shown in detail on the drawing.

Bolts of ⅝-in. round iron were used in the various connections of the bents, only two lengths being required, 10½ ins. long for the batter legs and 12½ ins. long for the plumb or central leg. The sway or lateral bracing was made of 2×6-in. lumber, bolted at the ends and at the intersections. The longitudinal bracing consists of horizontal waling strips, 2×12 ins. in size, well spiked to the outside of batter legs. An additional system of inclined longitudinal bracing was used in the middle story, consisting of one piece of 2×8-in. lumber for each span. This was secured by spiking to the plumb legs.

The flume proper was planned to be 2 ft. wide and 1 ft. deep. This was modified before construction by making the same 30 ins. wide inside. The sides of the flume were made of 3-in. plank, the bottom being 2 ins. thick, composed of pieces 3 ft. long, and nailed at right angles to the sides. To support the flume at the center, three braces, 3×8 ins., were employed, the toes of which rested upon the intermediate caps and these were also well nailed to the center legs, with which they were in contact. The flumes were made in 20 ft. lengths and abutted. The ends of the flumes were secured by a plank 2 ft. long, spiked to the outside ends and dapped down over the caps. Several methods of erection were discussed, and it was finally decided to frame and put each bent together, arranging them in logical order on the ground, and in such a manner that when erected each bent would be in its proper position. It was found that owing to the lightness of the timber employed, the high bents would not possess sufficient stiffness against flexure, and to remedy this to some extent additional temporary timbers were lashed to the legs while in the course of erection. The accompanying photograph, Fig. 2, shows a portion of the trestle in place, and one bent being raised to a vertical position. Placing the flumes in position occupied considerable time, as each section had to be carried out whole on the completed structure, and then projected out over the end of the last finished bent. To facilitate this placing, the last erected bent was allowed to lean towards the working end of the trestle, and as soon as the forward end of the flume was securely attached to the leaning bent, this latter was drawn to a vertical position, drawing the flume with it.

The trestle was not erected without accident. After bent No. 13 had been erected and was being held in position by temporary guys, one of these, composed of two ropes, parted by the slipping of a knot, and the bent fell towards the finished work, carrying down in its fall bents Nos. 12, 11 and 10, which were as yet not stayed nor fully braced. By a singular fatalism, the bent that fell was No. 13. Luckily no persons were injured by the accident, and but little actual damage was done, although the resulting loss of time and expense of erection was considerable.

The total amount of lumber in the structure is about 23,000 ft. B. M., which cost, delivered on the ground, $12.50 per M. ft. B. M. The lumber was all oak. The cost of erection was about $500, which was large. Much of this can be attributed to the difficulty of erecting, as well as to the accident mentioned above.

EXPORTS OF WIRE NAILS from this country have greatly increased during the past three years, and especially during the last year, as is shown by the following figures of the total exports of nails from the United States for four successive fiscal years:

Year ending	Cut		Wire and all other.	
June 30,	Pounds.	Value.	Pounds.	Value.
1896.....	20,730,260	$428,630	8,031,927	$321,055
1895.....	16,895,428	283,646	4,367,267	210,192
1894.....	16,736,643	330,118	3,233,776	180,607
1893.....	15,604,347	330,554	2,300,501	158,033

It is stated that at present American nail makers are beating the German firms in their competition for the trade of Japan, China and Australia, and this in spite of the fact that the Germans have much less freight to pay on the goods shipped to those countries than the Americans.

THE ADVANTAGE OF TRADE STANDARDS in securing export orders is well illustrated by the success of American pipe makers in securing South African orders. The story is told by London "Engineering," as follows:

The advantages of a set of standards generally recognized in the trade are well shown in the recent orders sent from Johannesburg to the States for iron piping. Formerly this was obtained entirely from the Clyde, but the different makers had all their own standard sizes for couplings, unions, etc., with the result that a batch of such goods received from one Scotch firm could not be used interchangeably with the goods supplied by another. American makers have agreed on a set of standards, to which all work, and for this reason only they are getting a large share of the South African trade. When complaints were made the Scotch firms defended themselves by the inane remark that their own fittings were interchangeable inter se, and they professed to be unable to understand why this was insufficient. Not so very long ago certain makers held similar ideas as to screw threads. In short, they rather thought they scored a point in having their own standards, as they fondly imagined that then all repairs must be returned to them for execution. Experience has, however, shown that a careful colonial importer avoids placing his orders with such firms, as the annoyance of having to send some thousands of miles to replace a broken bolt can only be balanced by a very substantial saving in the original cost of the goods.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The proposed filtration of Philadelphia's water supply has been again brought to the front by the presentation of a report on the matter prepared by Mr. Allen Hazen, who was engaged for that purpose by the Woman's Health Protective Association. We have briefly summarized this report elsewhere in this issue. The need of a decent water supply for Philadelphia is well known; sooner or later the use of the foul and noxious Schuylkill water must be abandoned, and the sooner this is done the sooner will the annual sacrifice of human lives to the diseases spread by that contaminated water be ended. The question which for nearly a generation has been a mooted one in Philadelphia is what shall take its place? If the plan is adopted of going to some natural stream with abundant flow from a drainage area so far removed from populous towns as to ensure against serious pollution for many years to come, then the only available source of supply appears to be the upper Delaware, and this would mean the construction of a conduit of sufficient size to carry the city's entire supply and nearly 100 miles in length. It is no wonder that the city has hesitated to undertake so gigantic an enterprise.

But within the past few years engineers, and to some extent the general public also, have come to understand the practical possibilities in the purification of water by filtration; and it is quite possible that it may soon be accounted better practice to take water and filter it from a stream more or less polluted that flows past a city's doors, than to go long distances for a potable supply which often in a few years will become polluted. Philadelphia, for example, instead of going a hundred miles up the Delaware for a pure supply can take water from the same stream as it flows past the city, and by the process of filtration can make it as pure as the water of the mountain brooks that feed it. Mr. Hazen estimates the cost of a filtration plant at Philadelphia, capable of furnishing an average daily supply of 195,000,000 gallons, at $3,400,000. It will be seen that this is an insignificant sum compared with the cost of bringing the same amount of water from the Delaware Water Gap, and no one familiar with the actual results obtained in sand filter beds can doubt that it would actually be purer and safer water than that of the river as it flows at the Water Gap, provided, of course, that the filters were so designed and so operated as always to give the maximum degree of efficiency attainable by this process.

We believe the fact is too often lost sight of in making comparisons between a filtered supply for a large city and a supply obtained from a distant watershed, that any stream large enough to supply a great city must at times carry more or less pollution. The watershed of any such stream must have on it more or less farms and villages, the drainage of which will often go directly into the streams unless great expense is incurred in the purchase and foresting of large areas, and their sanitary policing. In the case of such a great area as the Delaware watershed above Trenton, such a task would be practically impossible. Again all such streams are subject to sudden floods, during which great quantities of sediment, road washings, and the flushings of farm yards, pastures, house drains, etc., are carried into the stream and brought down. Should the question become an issue in Philadelphia between going to the Water Gap for a supply and installing a filtration plant, we suggest that those in favor of the latter take their opponents on an excursion to the Water Gap at a time when the river is in flood.

Whether Mr. Hazen's estimate of the amount of supply required and the cost of the filtration plant to furnish it are correct or not, it is at least fairly certain that the Philadelphia supply could be filtered for a small part of what it would cost to bring water from the Gap, or for that matter from any of the other sources which have been considered at various times.

The remarks Mr. Hazen makes with respect to the waste of water in Philadelphia are excellent. It is generally understood nowadays by all water-works engineers that the way to reduce waste of water is to install meters; but with the mud and grit and culm which Philadelphia water carries, any water meter is bound to wear more or less; and when a water meter becomes so worn as to lose its sensitiveness, so that it does not register the small flows due to leaky fixtures, a large part of its value as a means of preventing water-waste is lost. On the other hand, as soon as filtered water is distributed in Philadelphia, meters could be generally introduced, with a certainty that accurate registration and durability and freedom from repairs would be assured. By this means it is quite certain that the water consumption of the city could be reduced to a reasonable figure, and the saving made in this way would go far toward paying the cost of maintenance of the filter beds.

We publish on another page an abstract of the report of Mr. R. S. Hale, Expert to the Steam Users' Association, on Steam Boiler Practice in Europe, which will be of interest to steam engineers. In the types of boilers used there appears to be a great diversity in the different countries. For instance, in England the Lancashire, Cornish and similar types form 61% of the whole number of boilers used, while in France only 12.9% of the boilers are of this type. The externally fired cylindrical, including the elephant boiler, is most common in France, 57.3% of all the boilers being of that type, while England has only 6.8%. England uses 16.6% of small verticals, while France uses only 3.6% and Germany 5.0%. Germany uses 17.3% of locomotive boilers, France only 5.1%. In the United States the plain externally fired multitubular boiler is the most common, but in England it does not appear to be used at all, while France uses 13.4% of that type. We regret that Mr. Hale did not procure statistics showing what kind of boilers had been purchased in the different countries say within the last ten years. We have no doubt that if such figures could be procured they would lead to different conclusions than those which may be obtained from the table given. The boilers now in use in Europe are to a great extent survivials from a past generation. Boilers often last 30 or 40 years, especially in England, where they are well taken care of. The Cornish and other single flue internally fired boiler, which forms 23.7% of the existing boilers in England, is certainly a survival, as is the elephant boiler in France, and the two-flue externally fired boiler in this country. Neither one of these types would now be adopted in a new plant designed with proper consideration of economy of space and of fuel.

A careful reading of Mr. Hale's report will show that Europe is by no means ahead of this country in steam practice in any particular, except in the use of superheated steam. Mechanical stokers are in more general use abroad than here, but they are rapidly being adopted here.

In boiler economy it appears that Europe is neither ahead of nor behind us. From 70 to 80% of the heating value of the coal is obtained in good practice both here and abroad, and the difference of 20% in the practice of different plants is not yet satisfactorily accounted for. In attempting to make a "heat balance" in boiler tests in England, as much as 15% of the heat has sometimes to be set down as "unaccounted for." In order to find the truth about the 5% to 15% of heat thus lost Mr. Hale is now conducting some experiments on a boiler in the vicinity of Boston. Mr. Edward Atkinson, president of the Steam Users' Association, in an introduction to Mr. Hale's report, states that with the completion of this work "the present undertaking may end, unless suggestions be made for the continuance of this service in some form after the present year."

We regret that after all of Mr. Atkinson's attempts to improve the knowledge of steam engineering in this country his labors in this direction are apparently about to come to an untimely end, in fact just as the real work is about to begin, for the several circulars requesting information from subscribers which the Association has sent out, the compilation and publication of the returns, and Mr. Hale's trip to Europe have all been but preliminary to the work which may lead to an answer to the question "How may we improve our boiler economy?" In Engineering News of July 18, 1895, we gave an account of the work which Mr. Atkinson then proposed to do. He then thought that "the manufacture of steam as a separate art may be better comprehended in Great Britain than in this country" and he proposed to set two experts at work, one of them in Europe, to develop "rules for the manufacture of steam in the safest and best manner." The result of the investigation thus far has been to show that Mr. Atkinson was mistaken in his supposition that Europe was in advance of this country in the "manufacture of steam," and there does not seem to be any probability that the experiments on a boiler in the vicinity of Boston that are yet to be conducted will lead to any conclusions from which may be developed "rules for the manufacture of steam in the safest and best manner." It is too bad that "the present undertaking may end unless suggestions shall be made for its continuance." We, therefore, venture a suggestion. The work which Mr. Atkinson attempted to do is a most valuable one and it should be continued, although by different methods. There is an enormous waste of fuel in this country in the average (not in the best) steam boiler practice, and especially where bituminous coal is used. Mr. Atkinson is a great friend of Southern enterprise, and especially its great exhibitions. At the Tennessee Centennial exhibition next year there will be a fine opportunity to make competitive tests of steam appliances. Let Mr. Atkinson organize a bureau of tests of steam boilers, of smoke consumers, of boiler furnaces, mechanical stokers and the like, which shall test every appliance of that nature in the exhibition. We also make another suggestion. His experts have reported, and we believe correctly, that all types of boilers if properly designed and run give practically equal efficiency. It is not tests of different types of boiler that are now needed, but of different kinds of furnace under the same boiler, with different kinds of coal and different methods of firing. Let him try to solve this problem: "Given a 200-HP. water-tube boiler, and six different kinds of coal of widely different qualities, what kind of setting, what method of firing, what force of draught and what size and

FIG. 2. RESERVOIR FROM NORTHEAST END,
DAM AND ENTRANCE TO DRAIN TUNNEL ON THE LEFT.

FIG. 3. RESERVOIR F
SHOWING WATER FLOW

FIG. 4. POWER HOUSE, PIPE AND TRANSMISSION LINES.

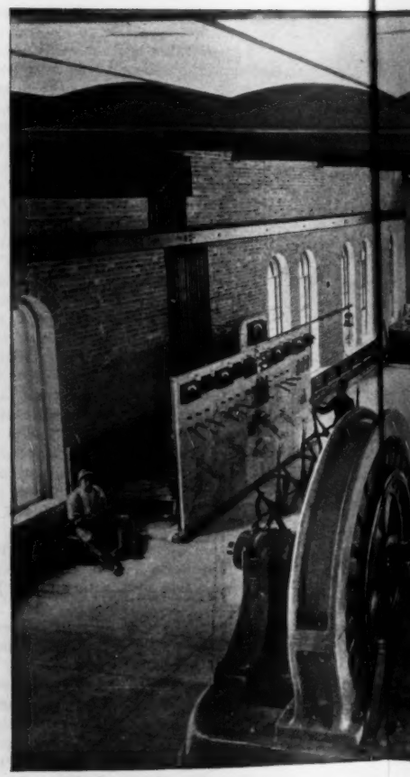
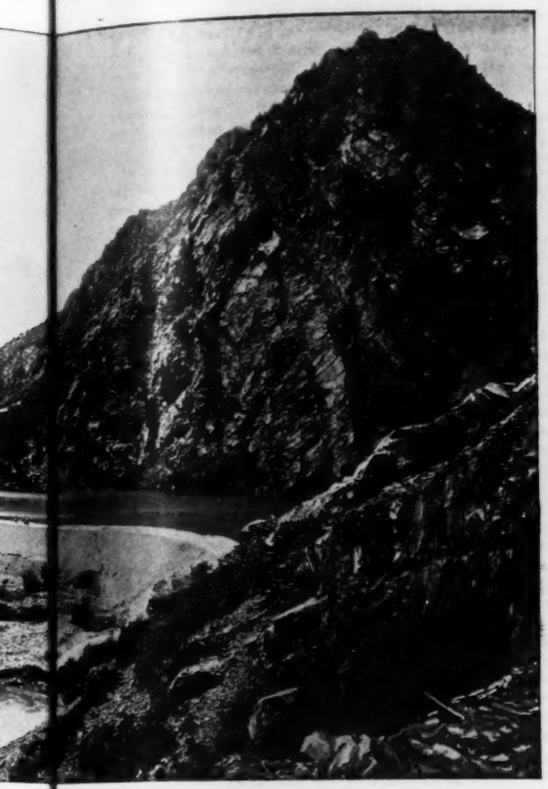
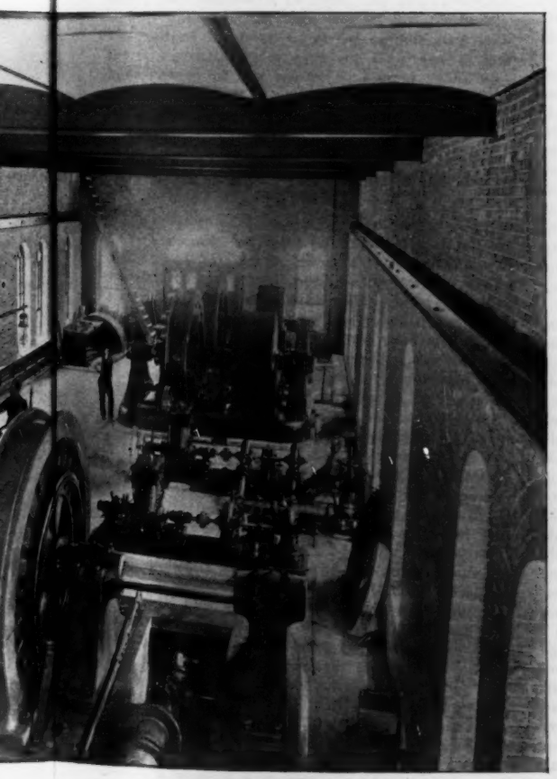


FIG. 5. INTERIOR OF



RESERVOIR FROM BELOW THE DAM,
WATER FLOWING FROM DRAIN TUNNEL.



RIOR OF POWER HOUSE, FIRST FLOOR.

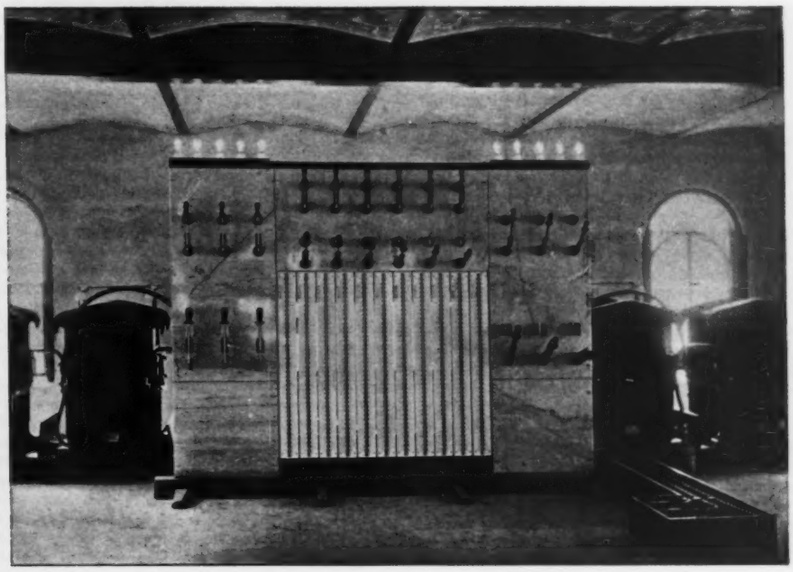


FIG. 6. SWITCHBOARD AND STEP-UP TRANSFORMERS ON SECOND FLOOR OF POWER HOUSE.

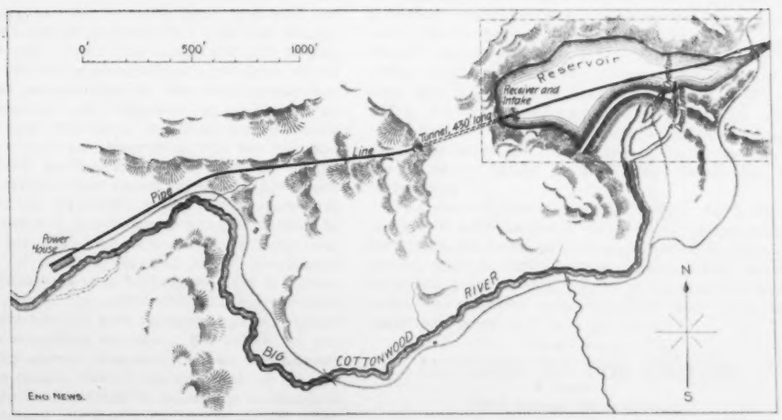


FIG. 1. MAP SHOWING LOCATION OF RESERVOIR, BIG COTTONWOOD CREEK, PIPE LINE AND POWER HOUSE.

WATER POWER AND ELECTRIC PLANT OF THE BIG COTTONWOOD POWER CO., SALT LAKE CITY, UTAH.

R. M. Jones, Engineer.

kind of grates are required to produce the best results with each of the different kinds of coal?" If Mr. Atkinson will now collect funds to pay for an investigation which will lead to the answer of this question he will advance the science of steam making to an extent far beyond anything that could be expected from the methods he has hitherto adopted.

In connection with the coming use of motor-carriages the construction of the wheels is very important, and the notes upon the relative traction values of iron, pneumatic and full rubber tires, given in another column in this issue, are useful and interesting. The pneumatic, full rubber and the iron tire, so far as the effort of traction is concerned, have relative values, in round numbers, of 100, 130 and 133, showing a general economy for the pneumatic of about 30%. But besides this economy in power required there are other and important advantages in the use of the new wheel; and these are the reduction of the effect of sharp shocks and the marked decrease in noise and the wear and tear on the vehicle itself. As to this feature of noise, it may be remarked that the pneumatic tire on a low wheel of the bicycle type is now quite common among the cabs of Paris, and over the smooth wooden or asphalt roadways of that city these tires make so little noise that, for the safety of pedestrians, an ordinance has been passed requiring the owners of cabs to put bells upon their horses. In this way, while the rattle of carriage wheels is much reduced, the jingling of bells is substituted for it. But the person using the carriage gains decidedly in comfort, and the low wheels have advantages in getting into and leaving the vehicle. As shown in the cut reproduced, the wearing part of the rim is heavily armed with rubber and inquiry failed to find any cases of punctured cab tires. The fact that pneumatic tires were actually used fifty years ago, and that they practically differed very little in construction from those now placed upon carriages, will be new to many of our readers. But just as the bicycle, or velocipede, was introduced over seventy years ago, and then laid aside and forgotten, so the condition of our streets and highways, in 1846, was not favorable for the improved carriage tire of Mr. Thomson. The modern development of the bicycle, and now the motor-carriage, is a direct resultant of the improvement of our roads; and good roads and more of them will always be an important factor in the growth of all efforts towards cheaper and more rapid transit upon them.

HOW CAN BETTER BUILDING INSPECTION BE SECURED?

The collapse of a building under construction in New York city on Saturday last calls attention again very forcibly to the fact that building operations in every city need to be very carefully watched in the interest of public safety to prevent careless and wilfully bad work being done. This is by no means the first time that such a disaster has occurred in New York city, and in some of these cases its Building Department has been held partially responsible on account of the careless or dishonest manner in which its duties were discharged under former administrations. In the recent disaster it is clear that serious defects and violations of the building law existed in the structure and were not discovered by the Department's inspectors; but on behalf of the Department it is said that the funds available do not permit the employment of a sufficient force of inspectors to prevent violations of law and bad work. Each inspector is said to have from 90 to 150 new buildings under his charge, and it is manifestly a physical impossibility for him to keep such close and continual watch on each of these as to certainly detect defects and unsafe work.

Another instance of defective construction was recently discovered by Philadelphia's Building Department. A row of 16 new houses was condemned by it, but the owners protested, and in response to their request the Director of Public Safety appointed a special committee to examine the houses and make a report thereon. The following is quoted from this report:

> Walls not plumb, and in some instances cracked; 9-in. party walls, where there should be 13-in. walls. Front walls not tied to party walls in either first or second stories; bricks laid without joints being flushed up, or cross joints put up, and in many places without any mortar whatever. Lintels not used properly, and in many cases there are no lintels at all over the frames. Flue linings not used properly. Inferior joist and roof rafters, in some cases being too short, and spliced out with 1-in. boards. Chimneys lathed and plastered over, also heat pipes. The heat pipes have been run without protection to woodwork or studding. The chimneys are not tied into the walls. The walls in some cases are composed largely of bats. These houses are, in our opinion, dangerous, and have no redeeming features, and we advise that they be torn down to the foundation walls and the foundation walls examined before rebuilding commences.

These two notable cases of defective construction, with others that are occurring from time to time in other cities, should call attention to the question what can be done to more certainly detect defects and unsafe construction.

For many years past more and more responsibility has been laid on the city building bureaus; the building laws have been made more and more complex and detailed, and reliance has been placed upon the official inspectors to see that the laws are carried out. We have no word to say against this tendency and consider it emphatically the duty of every city and town to see that the buildings within its limits are so constructed as to afford reasonable safety to their occupants and reasonable security against the spread of fire. But at the same time it appears to us that this inspection by public officials should not be allowed to take the place of a systematic inspection by the owner or his agents during construction.

Let us take the case of New York city. If we are correctly informed, the total amount expended in new buildings and alterations of existing structures is about $90,000,000 per annum, while the total appropriation for the annual expenses of the city's Building Department is $265,000. Probably at least a third of this sum is expended for the office employees, who examine plans filed with the Department, and in general office expenses, superintendence, etc. This leaves about $177,000 to pay for actual inspection of buildings, or roughly, about one-fifth of one per cent. of the total expenditure on construction. Any engineer or architect can easily see that this is far too small an allowance to ensure a thorough inspection. On the simplest class of civil engineering works, such as bridge pier or retaining wall construction, an allowance of ½ to 1% for inspection would not be excessive; and manifestly a much larger amount should be expended for inspection of ordinary building construction; if good work and strict compliance with specifications is to be ensured. On the other hand, of course, the city building inspector need only concern himself with matters of safety, which somewhat simplifies his task. We believe it will be generally agreed, however, that an expenditure of not less than a half of one per cent. of the annual outlay on buildings is necessary to enable a city to inspect properly the construction work going on within its limits.

It appears, therefore, that allowing every city building department to be honestly and efficiently managed and every one of its inspectors to be absolutely honest and faithful, it is still certain that with the limited appropriations which are generally allotted to city building departments, their inspection must be too hasty and incomplete to ensure discovery of every defective building, even though they may usually succeed in doing so. The time may come when this will be remedied—when ampler means will be furnished to building departments for their work; but it should be fully understood that under existing circumstances, the inspection made by the city should never take the place of or relax the vigilance of the inspection that should be carried on on behalf of the owner.

It is in this class of inspection that a great opportunity for improvement exists. The best architects, conducting a large and well-systematized business, have efficient corps of inspectors; but on the great bulk of building construction carried out under the direction of ordinary architects, or in many cases without the aid of any architect, inspection is too often a very cursory affair.

That this should not be, goes without saying. The owner of a building is responsible for its safety. If it falls because of bad construction and death or injury result to the inmates, he can be held for damages. Further, most insurance policies contain a clause making them null and void in case of the fall of the structure which they cover. The owner of a building who neglects to provide inspection to ensure its safe construction, therefore, runs a heavy risk. Besides this, an expenditure for inspection will mean in many cases a more durable structure, one which will involve less expense for repairs for many years. The owner, therefore, who, to save money, neglects to secure inspection of the structure he is building is saving at the spigot and wasting at the bunghole.

It has seemed to us in considering this question of building inspection that there is an opportunity here for the establishment of enterprises similar to the inspection bureaus which have made so pronounced a success in the examination of iron and steel, bridge work, etc., or those which cut so prominent a figure in marine architecture. Once let such a bureau acquire reputation for integrity and thoroughness and its services would be everywhere in demand. At present the purchaser of a building has no adequate assurance that the structure is soundly and securely built. Any such purchaser would pay somewhat more for a structure if with the deed he received a certificate of an inspecting bureau of wide reputation that the structure had been continuously inspected during its construction and had received approval. Moreover, when it became customary for purchasers to ask for such certificates, builders who erect houses to sell, as well as owners building for their own occupancy or for investment would find it to their advantage to employ such a testing bureau. Financial institutions, also, would demand such a certificate as precedent to granting a loan upon the structure.

It can easily be understood, moreover, that such a bureau could perform the work of inspection more efficiently and economically than the ordinary architect. It could, for example, have special men to inspect machinery, lighting apparatus and other special details of the work with which the average architect or his assistants are often not familiar. Thus many architects would prefer to place the inspection of their work in the bureau's hands rather than undertake it themselves.

We have outlined the above merely as a suggestion of what seems to us to be a hopeful plan for the improvement of the character of buildings; and we hope that some of the engineers and architects who have made a success of the inspection of metal construction may see their way clear to undertake work in this larger field.

LETTERS TO THE EDITOR.

Civil Service Examinations.

Sir: I desire to inform you that there will be an examination for the position of Plumbing Inspector by this Board on Thursday, Oct. 8, beginning at 10 a. m., and will be greatly obliged if you will insert notice of such examination in your journal. Applications will be received only from residents of the State of New York.

Yours respectfully, S. William Briscoe,
Secretary New York City Civil Service Boards.
New Criminal Court Building, New York city,
Sept. 25, 1896.

Water Development on the Mojave River, near Dagget, Cal.

Sir: I wish to call attention to an apparent error, referring to my article in Engineering News for Sept. 3, 1896, "Water Development on the Mojave River." The last sentence of the first column, page 150, reads: "In this case, where the sheet piling brings the water plane constantly above the flume grade, it would seem that the gathering flume might have been dispensed with."

I have no copy of my manuscript here in camp, so I cannot now compare, but I presume the sentence was originally written as follows: "In this case, where the sheet piling brings the water plane constantly above the flume grade, it would seem that the floor of the gathering flume might have been dispensed with."

Yours truly, J. B. Lippincott.
Strawberry, Cal., Sept. 16, 1896.

Water Tigers and Water Supplies.

Sir: When cleaning out a distributing reservoir here last May there was considerable alarm manifested over the

presence of numberless worms covering the entire sediment at the bottom of the reservoir. It was feared that they might be permanent inhabitants of the water and liable to continual distribution through the service pipes of the city.

Specimens submitted to an entomologist, however, were pronounced to be the larvae of the so-called water tiger belonging to the caleroptera. Among them were the hydrophilidae, gyrinidae, dytiscidae, etc. They are reported to have a remarkably rapid transition from this form to the next, which is that of the flying beetle. It is said that it deposits on the water the eggs from which these larvae are produced; also that it is not injurious to water for domestic use, and in fact is a scavenger in the water, tending to purify it rather than pollute it.

Their presence in the water is of such short duration that their discovery was accidental. A question arises as to how often our drinking water is similarly inhabited.

I would like to ask if this is a common experience, and if so what influence this insect really has on the quality of the water? If harmful, what is the usual treatment?

Respectfully, H. B. Patten, City Engineer.

Cheyenne, Wyo., Sept. 14, 1896.

(We do not recollect a similar instance, and should presume that the authority consulted was right in pronouncing the visitors entirely harmless.—Ed.)

Cost of Testing Steel Tapes.

Sir: In the Sept. 24 number of your valuable journal, under the caption of "Testing Steel Tapes," the statement appears that our charge for testing a steel tape of 100 ft. is $25, and we are at a loss to understand how such an erroneous impression originated.

The facts are as follows: We charge only 50 cts. for comparing with our standard the whole length of any tape of 100 ft. or less, and 10 cts. additional for each intermediate graduation actually tested. We compare many tapes from all parts of the country, and sometimes from other countries, and frequently the total length only is desired, the total charge in that case being only 50 cts. If both sides are graduated, one in feet and the other in metric measure, and both are tested, the charge of course would be doubled. It is seldom that a test of more than ten of the intermediate graduations is called for, and the additional charge in that case would only amount to $1. The amount of work expended on a tape, therefore, depends on the wishes of its owner.

It has always been the policy of this office to make the charges for such work merely nominal, and in view of the great importance of this matter to engineers, surveyors and others, we trust you will insert in your next number a correction of the statement above referred to.

Yours respectfully, W. W. Duffield,
Supt. U. S. Coast and Geodetic Survey.

Washington, D. C., Sept. 29, 1896.

(We are pleased to make the above correction and are sure that many engineers will be interested to learn that they can have their tapes verified at so trifling a cost. We were misled by a statement made before the Ohio Society of Civil Engineers and Surveyors in discussing the testing of tapes.—Ed.)

Sir: Following the inquiry by Mr. Erlandsen in reference to testing steel tapes, the writer wishes to call attention to an experience in this line showing a discrepancy between the United States standard tests at Washington and the method employed for testing by at least one prominent tape manufacturer.

The tape in question was received from the manufacturers as being 300 ft. long. It was at once sent to Washington, and by the Department of Standard Weights and Measures reported to be 0.52 in. long under a pull of 10 lbs. When the attention of the manufacturer was called to this, they at once claimed that 10 lbs. was more tension than the tape should have when supported throughout its length, and that their own tests were made under a pull of 2 lbs. This at once explained the difference in length.

The question then arises, why should a manufacturer assume a method for testing steel tapes which is known to differ from that employed by the Department of Standard Weights and Measures? Assuming that their standards for comparison are of the same length, the tapes manufactured and sent out by them must always exceed the U. S. standard length when tested by the Department at Washington.

It would be interesting to know if it is common practice for manufacturers of steel tapes to each make and test his work as his own individual ideas would suggest and to send these tapes out as being of correct length.

Yours truly,
Edwin D. Graves, Assoc. Am. Soc. C. E.

Hartford, Conn., Sept. 29, 1896.

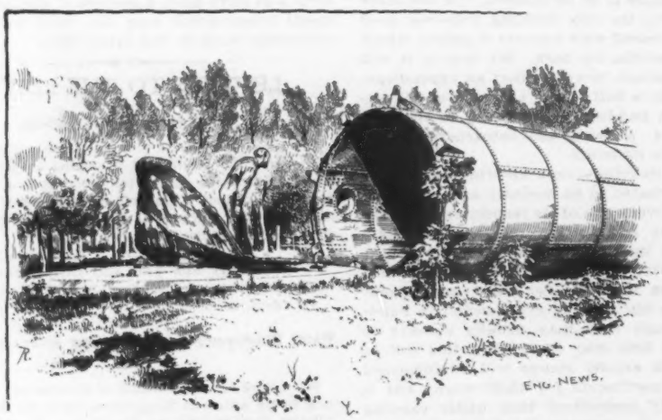
A Stand-Pipe Failure at Garden City, Kan.

Sir: A brief note in regard to the failure of the Garden City stand-pipe, another addition to the already large number of failures of these structures, may be of interest to the readers of Engineering News.

This stand-pipe was built by Palmer & Son, of Kansas City, Mo. It was located about one-fourth mile from the Arkansas River, and a few feet above its bed. It was 10 ft. in diameter, 130 ft. high, and was supported on a masonry foundation on a level with the surface of the ground. It was held in place by six 1½-in. bolts through six cast-iron brackets, and by six 1-in. wire guys fastened to masses of masonry 65 ft. from the pipe and to an angle iron 90 ft. above the base. The plates of the top course were ¼, and of the bottom course ⅛-in. thick. The vertical joints were double riveted and the horizontal joints single riveted, with ⅞-in. rivets. The structure was stiffened by five 3 × 3 × ⅜-in. horizontal angles, to one of which, 90 ft. from the base, rings were welded to hold the guys. The bottom plates were ½-in. in thickness, and were connected to the first course by 4 × 4 × ⅝-in. angles. The brackets were cast iron, legs 2 ft. long, fastened to the structure by ten rivets, and to the masonry by 1½-in. bolts.

About four years after erection a crack appeared on the west side of the pipe, in the angle iron connecting the bottom to the first course. This was soldered but continued to leak and about 2½ years before the failure a new piece of angle, about 5 ft. long, was put in. Four of the six brackets had their legs broken about this time, and were repaired by bolting to them a strap of iron which passed down around the anchor bolt.

On April 30, 1896, during a very high wind from the northwest, estimated to have a velocity of 60 to 70 miles per hour, with occasional gusts of 90 miles, and which wrecked many of the windmills in this vicinity, a crack appeared on the north side of the bottom angle iron. This crack increased in size for 1¼ hours, until it was 5 ft. long, with the water rushing out rapidly. Suddenly the angle iron to which the north guy was fastened gave way and the pipe blew over in the southwest direction. The pipe was about one-fourth full at the time of failure, with both pumps delivering into it at nearly their full capacity.



AN OVERTURNED STAND-PIPE AT GARDEN CITY, KAN.

The bottom angle iron broke at the angle all the way around, except where the new piece was put in, where the first course failed along the rivets. All the brackets were broken, and the bottom was broken somewhat at its center around the entrance pipe.

It seems quite clear that the failure was due to three causes: (1) The weakness in the angle iron connecting the bottom and first course; (2) to the brackets not being long and strong enough; and (3) to the fastening of the guys being weak.

E. C. Murphy,
Hydrographer U. S. Geological Survey.

Lawrence, Kan., Aug. 31, 1896.

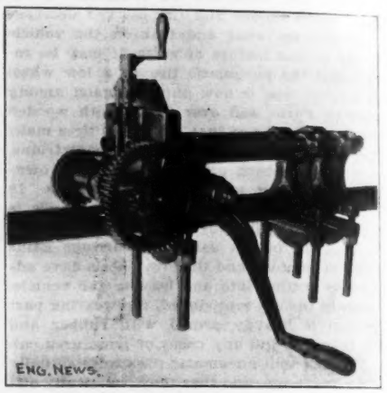
Notes and Queries.

T. W., Philadelphia, Pa., asks for a reference to some paper or publication on the construction of switch-back railways and of toboggan slides, as he has received a request on the subject from Japan and is anxious to supply the information desired.

The Paul Boynton Co., of New York, has patents on toboggan slides or chutes for boats to run down into a sheet of water, but we do not know the builders of any of the switch-back railways to be found at all pleasure resorts in this country.

A PORTABLE KEYSEATER.

The illustration herewith shows a portable keyseater, for cutting keyways in long shafts, manufactured by Messrs. John T. Burr & Son, Kent Ave. and South Sixth St., Brooklyn, N. Y. As shown in the cut the machine is clamped on the shaft and operated by hand. It will cut keyseats in shafting up to 5 ins. diameter, and will cut for 12 ins. in length without resetting. The cutting is done by milling cutters, and the machine is geared so that three revolutions of the crank produce one of the cutters. An automatic power-feed is provided, which can be instantly disengaged, and the machine fed by hand if desirable. A keyseat ¾ × ⅜ in. can be cut at one operation; for wider cuts the work is gone over more than once. A laborer can cut a keyseat ⅝ × 5-16 × 12 ins. easily in an hour. Larger size machines are also built to be operated by electric motor or by belt.



Portable Keyseater. Manufactured by John T. Burr & Son, Brooklyn, N. Y.

FILTRATION OF THE PHILADELPHIA WATER SUPPLY.

A vigorous crusade against the further use of Schuylkill River water, without filtration, is being led by the Woman's Health Protective Association of Philadelphia, and the subject is being actively discussed by the press of that city. All admit that the present supply is impure, and that the water from this river is blackened with coal dust or made yellow by mud at every high stage in the river, and that it is liable to contamination from six cities upon its banks above Philadelphia, whose aggregate population is 350,000. An entirely new supply, from a distant source of permanent purity, is undoubtedly the most attractive solution of the difficult problem presented, and for years past extensive surveys and investigations have been made with that end in view. But the enormous cost of such an undertaking, coupled with the lack of available means in the City Treasury and the disinclination to permit a private company to control the water supply of Philadelphia, have so far prevented any of the many projects of this sort which have been brought forward from being carried out.

Filtration has been often suggested, in Philadelphia. Several years ago certain parties backed

by the city press, seriously recommended the location of filter-beds or filter-galleries in the River Schuylkill itself, an absurd scheme, which was dropped as soon as computations were made of the area required for the quantity of water to be filtered, the cost of construction, and the difficulties and risks of maintenance. But since the success of sand filtration as a means of purification of water has become generally understood, the intelligent citizens of Philadelphia have become strongly in favor of the construction of a system of filter-beds. Our readers will recall that an appropriation to build a single filter-bed was before the Philadelphia Councils some months ago, and was only defeated by a close vote.

Recently the agitation for filtration has been started anew by the publication of a report upon the project of filtering the city's water supply made to the Woman's Health Protective Association by Mr. Allen Hazen, of the firm of Hazen & Noyes, of Boston.

This report has now been submitted to the Mayor by the Association, and the recommendations are about as follows: Mr. Hazen figures upon a population of 1,300,000 in 1900 and a per capita supply of 100 gallons per day. He admits that the maximum consumption now reaches 150 gallons per head per day, at times, but he believes that this could be reduced to the amount stated by the increased use of meters and by closer supervision of the daily consumption. He thus assumes a total filtering capacity of 195,000,000 gallons daily as ample for all purposes, with a reasonable system for the sale of water. He also assumes upon present European practice that the average daily yield for each acre of effective filtering area, of the character proposed, would be 2,000,000 gallons, for all seasons of the year and including the time the beds are out of service for cleaning. He figures that at times of maximum consumption 50% more water will be used than the average of the year; and at such times the filters may be operated at the rate of 3,000,000 gallons per acre daily. If this is not sufficient for these emergencies, the deficiencies can be made up by drawing upon the reservoirs.

The filters proposed are the ordinary sand filters, similar to those used at London, Hamburg, Altona, Liverpool, Amsterdam, Rotterdam and other cities, and in this country at Lawrence, Poughkeepsie, Mt. Vernon, Nantucket and elsewhere. These consist of water-tight basins, with masonry sides; the water-tight pavement carrying upon it underdrains surrounded by gravel and supporting a layer of sand. The water will be brought over the sand and filter downward, and would be collected in the gravel and carried by the drains to the reservoirs or to the pumps; a suitable regulating apparatus being placed at the outlet of the drains for controlling the rate of filtration and loss of head. Mr. Hazen would build the walls of the filters of brick, or rubble-masonry lined with brick, and would probably use concrete for the pavement with a thin water-tight covering of asphalt. He does not consider that the climatic conditions would require covering the filters; nor does he consider settling basins an essential for Delaware River water, but he believes this preliminary treatment would be desirable for water taken from the Schuylkill River. His plans contemplate for each set of basins, a receiving basin into which the water would be pumped from the river and from which it would flow to the filters. These receiving basins would hold one-fourth of a day's supply and the sedimentation which would take place in them would probably be sufficient. The Schuylkill River, he says, is ordinarily comparatively clear, and could be filtered without previous sedimentation. And as the high water turbidity rarely occurs at the time of maximum consumption, the filters would usually operate upon this water at a rate below the maximum.

According to a map presented with the report, Mr. Hazen proposes to establish these filters as near as possible to the Belmont, Roxsborough, Spring Garden, Queen Lane and Frankford pumping stations, with filtering areas ranging from 5 to 30 acres at each point, and with an average filtering capacity of from 10,000,000 to 60,000,000 gallons daily. The approximate cost of supplying 195,000,000 gallons daily of filtered water is placed at $3,400,000, and the cost of operation is estimated at $3.50 per million gallons of water filtered; or $166,075 annually for the amount stated. Mr. Hazen also suggested that when larger quantities of water were required it would be possible to obtain this supply from the Delaware River by means of filtration, and to use it in connection with that furnished by the present pumping stations. In this way a practically unlimited supply could be secured, at least 1,000,000,000 gallons per day being available.

Mr. John C. Trautwine, Jr., Chief of the Water Bureau, in speaking of Mr. Hazen's plan, said that the city is now consuming about 225,000,000 gallons daily, and unless steps were taken to stop the present great waste of water Mr. Hazen's filtering capacity, and the cost of the plant, would have to be doubled.

The consideration of the merits of the two water sheds as gathering areas for a city water supply was a feature of Mr. Hazen's report. The Schuylkill River, above the water intakes, has a drainage area of 1,900 sq. miles and the population upon this water shed, above Philadelphia, is 350,000, or about 185 persons per square mile. The Delaware River, above the city intakes, has a drainage area of 8,100 square miles with a population, in 1890, of about 600,000, or an average of 74 per square mile. Yet 94% of the present Philadelphia water supply comes from the Schuylkill basin, and only 6% from the Delaware River. Mr. Hazen also pointed out that the existing eleven reservoirs in the Philadelphia supply have a nominal aggregate capacity of 1,400,000,000 gallons, equivalent to about seven days' supply at the present rate of consumption; but owing to the defects in some of these reservoirs the actual aggregate storage is about 1,000,000,000 gallons, or five days' supply.

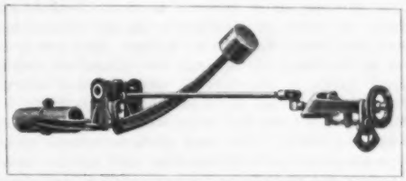
TEST OF A FIREPROOF FLOOR.

In our issue of Sept. 17 we described the tests which are being made by the Department of Buildings of the City of New York to determine the resistance to fire and water of various systems of fireproof floors. The third test of the series was made on Sept. 29 at the testing ground at 68th St. and Avenue A. The floor was built by the Central Fireproofing Co., of No. 874 Broadway, New York city, and was of the ordinary construction of 10-in. iron beams set 4 ft. apart, with the spaces filled in with 10-in. cellular blocks of porous terra cotta set endwise. The lower flange of the beam was protected by a 1-in. tile carried by projecting flanges of the adjacent blocks. The construction was identical with that used in the new building of the Corn Exchange Bank, the blocks being part of the lot made for that building. Two sections of the floor were loaded with brick to 150 lbs. per sq. ft. and a fire of cordwood was started at 9 a. m. in the brick room of which the floor formed the roof. In about an hour a temperature of over 2,200° F. was reached. The fire was maintained for six hours when a stream of water of 60 lbs. pressure from a fire engine was thrown into the room and against the underside of the floor. The result of the sudden cooling of the hot terra cotta blocks was to crack the lower portions of some of them, but at no point was there a hole broken through, and the floor continued to support the load of 150 lbs. per sq. ft.

AN AUTOMATIC FEED WATER REGULATOR FOR STEAM BOILERS.

We illustrate herewith an automatic feed-water regulator for steam boilers, which has been placed on the market by Messrs. J. J. Thornycroft & Co., of London, builders of the well-known Thornycroft water tube marine boiler. This regulator entirely avoids the common objection to instruments of this class, viz.: that they have moving parts passing through stuffing-boxes, which are apt to give trouble by their friction whenever the packing is tightened. Its principle is similar to that of the ordinary ball cock used on house cisterns. A float formed of solid drawn steel causes a lever to rise and fall with the water level and so to shut or open a valve placed inside of the boiler, which controls the admission of feed water.

The important novelty in this regulator is the method adopted for enabling the float to be adjusted to stand at a definite height, although the amount of valve opening required to admit sufficient feed water varies with different rates of steaming. This is done by mounting the fulcrum of the float-lever on one arm of a bell crank, the position of which can be adjusted by a rod which passes through a stuffing-box in front of

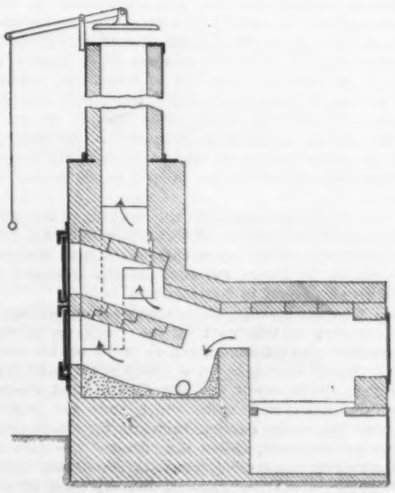


Automatic Feed-Water Regulator. Manufactured by J. I. Thornycroft & Co., London.

the boiler and which is provided with a screwed end. This rod can be moved to and fro by the screwed hub of a hand or chain wheel. An index to show the rate of working for which the position of fulcrum is adjusted completes the apparatus. Messrs. John Platt & Co., 97 to 103 Cedar St., New York, are agents for the United States.

THE GARRETT BRASS-MELTING FURNACE.

We illustrate herewith a style of brass-melting furnace, known as the Garrett furnace, which is being introduced by Messrs. J. W. Bennett & Co., engineers and contractors, 714 Lewis Block, Pittsburgh, Pa. In it crucibles are dispensed with, and at the same time the furnace is quite different from the ordinary reverberatory furnace. The metal is charged in the upper chamber shown in the cut, which is separated from the lower, or bosh, by a sloping fire brick arch. When the metal is heated it is pushed forward on the arch, and when it melts it drops down into the lower chamber out of reach of the oxidizing influence



Section of the Garrett Brass-Melting Furnace.

of the melting flame. The bottom of the bosh is lined with ganister, and it slopes toward the tapping hole. The furnace may run continuously, and it is claimed that in continuous use the bottom will last from five to to seven weeks without repair. The upper and lower chambers are each connected with the flue by fire-brick dampers, by which the heat in either chamber may be regulated. If the melted metal in the bosh becomes too cold it may be heated by opening the damper leading from the bosh and causing the flame to traverse through it. A furnace of 600 to 800 lbs. bosh capacity, capable of melting 5,000 to 6,000 lbs. daily, occupies a space of 30 to 40 sq. ft. The loss by oxidation in this furnace is said to be no greater than it is in melting in crucibles.

THE WATER POWER AND ELECTRIC TRANSMISSION PLANT OF THE BIG COTTONWOOD POWER CO.

By W. P. Hardesty, C. E.

(With inset.)

The water power and electrical plant of the Big Cottonwood Power Co. is situated on the creek of the same name in Salt Lake county, Utah. This stream has its source in the high mountains of the Wasatch Range in the eastern part of the county, heading next to the summit and divide between Salt Lake and Summit counties, and after flowing in a general westerly course for about 16 miles it emerges from the mountains onto the broad Salt Lake Valley. The creek is fed at its head by several fine lakes, of which Silver Lake is the largest and farthest down. From here, at an elevation of about 9,000 ft. above sea-level, the fall to the mouth of the canyon is about 4,000 ft. The creek gathers volume from its numerous small tributaries, and by the time it leaves the mountains has attained a size that, for eight months in the year, would justify calling it a river. The great fall of this stream, together with its large and reliable flow of water combine to render it peculiarly fitted for water power purposes.

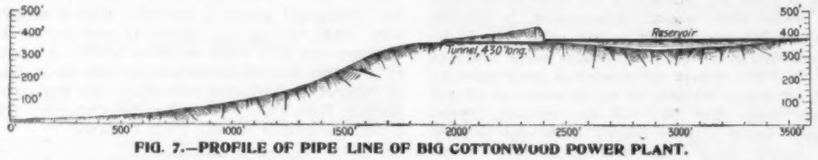


FIG. 7.—PROFILE OF PIPE LINE OF BIG COTTONWOOD POWER PLANT.

The map, shown in Fig. 1, of about nine miles of its lower part, including over one mile entirely out of the canyon, shows the course of the creek. Depending for its supplies for uniform and effective flow entirely on the melting snows or their results, never-failing springs, the stream is quite reliable for the production of water power. About three miles above the mouth of the canyon, begins a steep ascent producing what is known as "The Stairs." Here the rise is 200 ft. in one stretch of a little over ¼ mile, or the "Stairs" proper; nature has done much moreover in rendering this a peculiarly well fitted site for the production of power by having caused the creek to make a wide detour on account of a huge slide from the mountains having at some time pushed it across the canyon at this point, partly gorging it and raising the upper levels, and at the same time leaving a low neck or divide on the slide so as to permit water to be carried directly across it and save following the canyon in its horse-shoe curve.

The great advantages of this portion of the canyon for the production of water power, being only 14 miles from Salt Lake City, were first realized by Mr. R. M. Jones, the engineer and manager of the project about to be described.

In September, 1891, he located and appropriated the waters of this part of the creek for power purposes, and at once went to work on his project. Work was done on a small scale until November, 1893, when the Big Cottonwood Power Co. was organized, since which time the undertaking has been carried forward to completion. This development, called the "Stairs" Division or Plant of the company, consists essentially of a reservoir for storing water, a delivery pipe, so arranged that water can be taken either from the reservoir or the creek itself, leading down to the power house. The map, Fig. 1, shows the location of all parts.

Reservoir.

The minimum flow of the creek at the reservoir during the low water season is 3,400 cu. ft. per minute, and for eight months of the year is 5,000 cu. ft. The theoretical horse-power thus obtainable, with the static head of 380 ft. at the power house, is 2,450 and 3,600 respectively.

On account of the varying amount of power demanded at different hours of the day by the concerns it was intended to supply with power, it was decided to build a storage reservoir with a capacity for 12 to 24 hours supply, thus storing for maximum consumption, during the hours of the day when the consumption of water was the least.

At the location chosen for diverting the water the canyon widens out into a basin. Across the lower or southern portion of this an earth dam was thrown. This dam is 535 ft. long, 92 to 135 ft. wide at the base, 24 ft. at the top, and has a height of 19 to 31 ft. It is curved up the valley in plan to get it onto higher ground. The original creek-bed is near the eastern end. The slopes are 2 to 1 on the upper and 1½ to 1 on the lower side. As no suitable material for puddling could be procured at the site, it is homogeneous throughout. The material is a mixture of sand, clay and gravel, obtained from within the reservoir site. This was well compacted during building, having the advantage also of the rains during the year or more of construction.

The reservoir is oblong in shape, running east and west, and contains an area of 8¼ acres. The depth ranges from 10 to 35 ft., with an available working depth of 12 ft. With this drawoff depth the reservoir furnishes a supply of 55 cu. ft. per second for 24 hours, independent of the flow of the stream.

At the east end of the dam is an overflow waste-way, 30 ft. wide and 5 ft. below the top of the dam, being cut through the end of a sharp rock ridge. Through this same ridge and just east of the waste-way is a drain tunnel for carrying off the surplus flow of the creek. This tunnel is 180 ft. long and is timbered and planked inside to a section 6½ ft. square. It is through slate and quartzite, and the openings at the ends between the timber and rock are well back-filled with cement concrete.

At the entrance to the tunnel is a penstock for regulating the level of the water in the reservoir. This is 6½ ft. wide in the clear by 26 ft. high and 24 ft. long. The sides are brought up to the same elevation as the waste-way before described, and the front or upper end is provided with two iron gates and with movable flash-boards above them. The sills, posts and caps of the penstock are all 10 × 12-in. timbers; the bottom and sides are of 3 × 16-in. plank, bolted to these. The two cast-iron gates are each 3 × 3 ft., and are moved by screw-stems extending to cross-beams at the top, where they are operated by worm gearing. The gates move in iron guides. The penstock is sunk 7 or 8 ft. into the ground, and is well weighted down by heavy rock piled over the ends of its sills and other special projecting timbers near the bottom. When the reservoir rises above high-water level, the water pours over the sides of the penstock, falling to the bottom to be carried away through the tunnel.

The dam and underground fissures passed considerable seepage water at first, which has been gradually and nearly all shut off by placing additional dirt on the upper side. The water slope has also been rip-rapped with a layer of loose rock.

As the county road up the canyon passed through the reservoir site, it had to be changed to pass around, on the east side and high up the ridge before mentioned. This required much heavy and expensive work. Of the 1,200 ft. of length, 1,040 ft. is hill-side work, called "dugway," and 160 ft. is in a through rock cut, 60 ft. deep in maximum cut and passing through the ridge. The creek is crossed in a new place near the upper end of the new location, by a strong timber bridge on a heavy grade.

Tunnel.

In order to utilize the reservoir site and to take advantage of the "cut-off" across the low divide, already spoken of, to the power house site, it was necessary to tunnel through this divide to draw water from the reservoir. This was accomplished by a tunnel 430 ft. long, driven through the slate and quartzite. This was done by hand-power and by rotary electric drills of Mr. Jones' invention.

The summit of the divide is but 65 ft. above the tunnel. The tunnel section is 7 ft. wide by 7½ ft. high, and timbering was needed for only a short distance at the west or lower end. The grade of the tunnel is 0.2%.

Wooden Stave Pipes.

As it was desired to draw water from the creek as well as the reservoir, a pipe was laid to take water from the creek above the east end of the reservoir and carry it to a common regulating receiver or intake near the lower end of the reservoir.

The receiver of the wood pipe is made from a turbine case built for two different sized wheels, taken from a paper mill. It is 6½ ft. wide by 9½ ft. long and 6 ft. deep, with cast-iron heads and riveted steel sides. The front side was cut away for a diversion of water, being replaced by a screen composed of bars ¼-in. by 1½ ins. deep, ¾-in. mesh, and 48 sq. ft. in size. The intake is set in concrete and cemented at all joints. A cast-iron flange inserted at the back serves for connection with the wood pipe, oakum being used at the junction of ironwork and wood pipe at both ends of the latter. The approach to the intake is paved with shale slabs, and it is set so low that no dam is needed to divert water from the creek into it.

The pipe is laid in the reservoir for most of its length, it being preferable to do this under the conditions than to go around. It is 1,420 ft. long, 50 ins. inside diameter, and is made of Oregon fir staves, banded with steel bands. A circular section consists of 31 staves, each milled from a 2 × 6-in. piece, the thickness reduced to 1 11-16 ins. These are banded every 10 ins. with 9-16-in. round steel bands, upset and threaded at each end instead of one end, as is customary. By this it is claimed that the tightening is made easier and more certain, the drawing up being in a more direct line and with less friction. Cast-iron lugs are used for joining the ends of the bands, being really double lugs. The pipe is anchored down to the bottom of reservoir by loops of the same kind of wire, the end on each side being fastened to a "dead man" buried and weighted with rocks. Part of the pipe is laid on loose rock and part on earth, 100 ft. or more being laid on trestles. The average depth of the water over the pipe is 14 ft.

Receiver and Reservoir Intake.

This structure, being what is called the "valve tower" in most reservoirs, is at the west end of the reservoir. It is 7 ft. 2 ins. diameter, 24 ft. high, of ½-in. steel plates, and was made by altering a digester, also taken from a paper mill. It is set on concrete and is 32 ft. from, and directly opposite, the head of the tunnel. It has three 50-in. openings with flanges for connections to the wood pipe, a steel pipe outlet and the reservoir intake fitting. Over each opening and on the inside of the receiver is placed a simple 50-

Fig. 8.—Cross Section of Reservoir Dam, Big Cottonwood Power Plant.

in. flap valve, moving on hinges and raised and lowered by chains extending to a differential pulley block on top of the receiver. This is suspended from a three-legged angle iron stand surmounted by an iron umbrella for protection against weather. The top and bottom of the digester were of ¾-in. plate and curved, and to level it up on top a floor of cement was put on, encircled by a banded wooden cap.

The reservoir intake, for admitting water directly from the reservoir to the receiver, is enclosed by a heavy wire screen that is expanded to give a much larger area than the opening itself, to insure a full supply of water. The wooden pipe discharges into the receiver and the steel

pipe draws from it and leads to the power house. The three openings are 12 ft. below high water.

Steel Pipe.

The steel pipe passes through the tunnel and thence down the west slope of the mountain and valley to the power house.

There are 2,300 ft. of the following description:

Length.	Diameter.	Thickness.	Head.
636 ft.	50 ins.	¼-in.	12 to 75 ft.
224 "	50 "	5-16-in.	75 " 150 "
224 "	40 "	⅜-in.	150 " 225 "
224 "	40 "	7-16-in.	225 " 300 "
224 "	40 "	½-in.	300 " 380 "
992 "	40 "		

An ordinary section of pipe is 32 ft. long, being made up complete from four 8-ft. sections before shipment. The pipe is double-riveted, with flange connections and copper gaskets, each of the joints of the 71 sections being made up with 52 × 1¼-in. steel bolts. Each of these gaskets was made by taking No. 4 soft-drawn copper wire and wrapping it in a single layer of five complete turns in the joint between flanges. This was done by winding around a wood template placed on one flange, the wire being then soldered to the flange at intervals and the template removed. The flanges were then brought as closely together as possible with 4-ft. wrenches applied to the bolts, after which the joint was gone around with driving bar and set hammer and "flogged" to flatten the wire still more, this process alternating with tightening of the bolts two or three times till the wire was nearly flat and the joint perfectly water-tight. The gaskets thus made cost about 80 cts. each, while $2.50 to $3 would have been the cost of any of the ordinary gaskets on the market.

Thirty flange connections are on angles, with beveled joints, used on the curves, one horizontal and one vertical, each with a radius of 293 ft., and one compounded of a horizontal and vertical curve, giving a radius of 414 ft., and thereby also providing for expansion. The pipe is covered where deemed necessary, and on its steepest grades has inclined stay-braces of wood, abutting against the flanges and resting against timbers buried in the ground, to prevent its moving down hill. Thirty-two feet at the head of the pipe is submerged in the reservoir, thence the tunnel is entered, the pipe being passed through a concrete bulkhead, well cemented at the joints and placed about 15 ft. within the portals. A footwalk reaches from the cliff above the tunnel entrance to the intake receiver, being supported by four 2½-in. iron pipe columns set on flanges on the steel pipe below, and used both as columns for the bridge and for air valves for the pipe. Just outside the west end of the tunnel another air-pipe rises from the steel pipe. This is 4 ins. diameter, rises 18 ft. high or above high-water in the reservoir, and is open at the top like the others.

Power House.

The power house is located on the north side of the creek, some distance below the "Stairs" and the horse-shoe curve in the creek. The outside dimensions are 34 × 100 ft.; it has two stories, the first 21 ft. in height and the second 11 to 13 ft. in height.

The foundations are of concrete, with a 10 ft. bed under the machines and 2 ft. under the rest of the floor of the house, with cement coverings. The walls are of brick, the framework of steel, the second floor of brick arches and the roof of concrete, both built on I-beams. The structure is absolutely fireproof in every part, and is very substantial. The roof covering is of asphalt and gravel.

Upon the first floor are the water-wheels, the generating aparatus and the switchboards. The second floor has the step-up transformers with their regulating boards or panels, and also living rooms for the employees.

On the south side of the building is the tail-race, a pit built with very heavy concrete walls and bottom. It is 100 ft. long, 7½ ft. wide, 6 ft. deep at the upper end and 9 ft. deep at lower end.

The "header" or receiver is erected in this, being supported by cast-iron columns with large footings resting on the bottom of the pit. This receiver is 100 ft. long, 50 ins. in diameter, and is of ½-in. riveted steel plates, and cast-iron plates with radial braces at the ends. The discharge water passes along the pit, under the receiver, and thence can be discharged back into the creek.

Inside the building is a traveling crane with ten tons capacity, covering the entire area of the first floor of the house.

Water Power Machinery.

This consists of four special double-nozzle Pelton water-wheels, each is 61 ins. in diameter, and will develop 700 HP. with the effective head of 370 ft. obtained. Each wheel is keyed directly on the armature shaft of its generator. Water is supplied to each wheel through a 20-in. pipe tapping the receiver on one side and running horizontally through the wall, then making two 90° curves, one vertically to bring the water up above the floor, and one horizontally to turn the pipe into line with its wheel, lengthwise of the building. The curves have a 4½-ft. radius and are reduced to 16 ins. inside diameter.

Each wheel and its generator rest on one solid base-frame. Each nozzle is 3½ ins. diameter, the straight nozzles are each provided with a gate valve, and each lower nozzle is equipped with a hood regulator, to secure good regulation and economy in water consumption. The wheels run at 300 revolutions per minute, and each carries 20 buckets.

A cast-iron housing is placed over each wheel and the discharge water falls below and passes out through openings in the foundation wall to the tail race. As part of the hydraulic machinery, there is also a regulating equipment for each of the four generators. There are also all pipe connections, valves, gages and other appliances needed for regulation.

Electrical Generators and Equipment.

There are four three-phase generators with 24 poles, each having a capacity of 500 K-W. They generate a 500-volt current with a frequency of 60 cycles per second. Each has three armature bearings, having an extended shaft, and is on the same base-plate as its water-wheel.

There are two 25 K-W. independent exciting geperators, of the Edison bi-polar type. Each generator has capacity sufficient to excite the fields of all the alternators, and is driven from two 13-in. Pelton wheels, direct connected with the armature, and run at a speed of 1,300 revs. Generators and motors are set upon one cast bed plate. On the north side of the machinery room is erected the five-panel station switchboard, with complete controlling and indicating apparatus. There is also a tachometer driven by a synchronous motor.

Up-stairs are six 265-K-W. air-blast transformers, raising the voltage from 550 to 10,500. There is a Sturtevant exhaust fan for cooling the transformers, driven by a 5-HP. induction motor. Over 4,000 lbs. of soft rolled polished copper bars were used in the wiring of the station.

Transmission Line.

As this development of power was made with the primary object of transmitting electrical energy to Salt Lake City, the transmission line is made as direct as the country will allow, it being intended to run branch lines to such places as may demand it.

After leaving the canyon the line runs in a general north by northwest direction, and the total length to the distributing station, on South 3d and State Sts., in the city, is 14 miles.

The poles are of Idaho cedar, and are 40 ft. long and 9 ins. in diameter at the top. Some special ones are 50 and 60 ft. long and 10 ins. in diameter at the top. The poles are placed at an average distance of 120 ft. apart. Each has two cross-arms of spruce, each 4 × 6 ins. by 9 ft. These are fastened with lag bolts and braced on each side. There are six special pattern, double-petticoat, porcelain insulators to each brace, each tested to 40,000 volts. The line conductors consist of 12 wires, four circuits of three wires each. All of the circuits are of No. 2 B. & S. gage soft-drawn, bare copper wire and the total length of the wires amounts to 168 miles.

A telephone line is strung below the transmission wires, mounted on a short cross-arm to each pole. The telephone circuit consists of two No. 12 hard-drawn copper wires transposed between each two consecutive poles for its entire length. A total of 224,000 lbs. of wire was purchased by the company for its various uses.

The chief user of the electrical current furnished at the present time is the Salt Lake & Ogden Gas

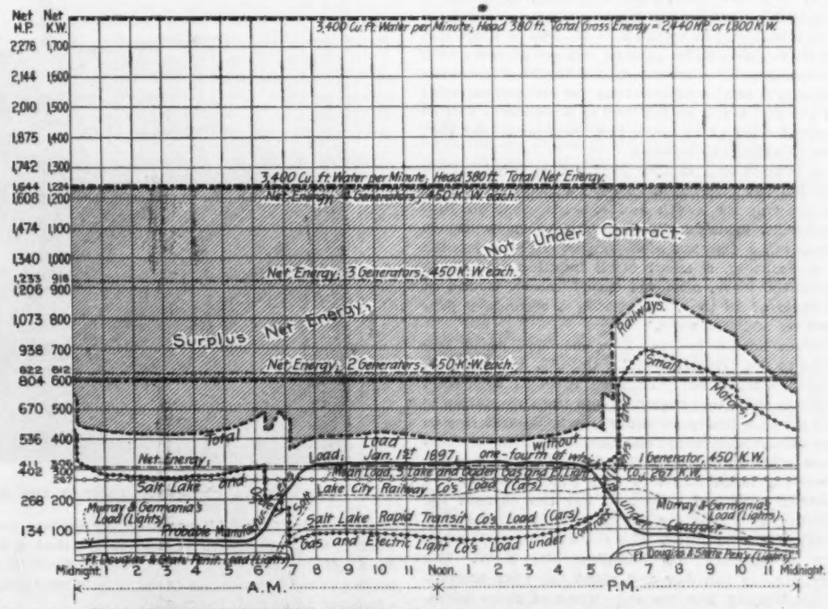

Net H.P.
Net K.W.
3,400 Cu. Ft. Water per Minute, Head 380 ft. Total Gross Energy = 2,440 HP or 1,800 K.W.
3,400 Cu. Ft. Water per Minute, Head 380 ft. Total Net Energy.
Net Energy, 4 Generators, 450 K.W. each.
Not Under Contract.
Net Energy, 3 Generators, 450 K.W. each.
Surplus Net Energy.
Railways.
Small Motors.
Net Energy, 2 Generators, 450 K.W. each.
Total Load.
Load Jan. 1st 1897, without one-fourth of winter Load.
Net Energy.
Salt Lake and Lake City Railway Co's Load (Cars).
Main Load, Salt Lake and Ogden Gas and Electric Light Co's.
1 Generator, 450 K.W.
Co's 267 K.W.
Murray & Germania's Load (Lights).
Probable Number.
Salt Lake Rapid Transit Co's Load (Cars).
Gas and Electric Light Co's Load under Contract.
Ft. Douglas & State Penit. (Lights).
Midnight 1 2 3 4 5 6 7 8 9 10 11 Noon. 1 2 3 4 5 6 7 8 9 10 11 Midnight.
A.M.
P.M.

FIG. 9.—DIAGRAM SHOWING AVAILABLE ENERGY, AT "THE STAIRS," OF THE BIG COTTONWOOD POWER CO. AND THAT UNDER CONTRACT AND ESTIMATED FOR, JUNE 1, 1896.

& Electric Light Co., which is the older and larger light company in Salt Lake City. By a contract to run ten years, from Jan. 1, 1896, the electric light company is supplied with all the current it can use and dispose of for light and power, its right to supply other parties, however, being limited to units of 10 HP. and under, for any one motor, except for elevators, where there is no limit. By the contract the current is bought at 2,200 volts at the sub-station at a stipulated price per K-W. hour, and 2,000,000 units annually is stipulated to be the minimum limit of consumption.

About 3,000,000 units per annum has been the production of the light company by use of coal. The distributing station or sub-station is owned by the light company, which rents it to the power company at a nominal figure. In it are nine 160

K-W. air-blast step-down transformers, reducing the voltage from 10,500 to 2,200, at which it is measured to the light company. There is also a three-panel switchboard, with regulating and other apparatus. A 24-panel Ball lightning arrester is also placed here. The following efficiencies of the different parts of the entire system are claimed by the builders of the machinery:

Water-wheels	80%
Generators	94%
Step-up transformers	97½%
Line transmission	95%
Step-down transformers	97½%

This indicates that a net energy of 68% of the theoretical horse-power at the power house will be delivered at Salt Lake City as electric current.

The load has not yet reached a limit which enables an accurate measurement, but it is thought that all the machines will fulfill the claims of the manufacturers; some tests have shown the efficiency of the Pelton wheels to be 85%. The plant has been in operation since June 2, 1896.

The power company also has the contract, to begin one year from June 15, 1896, for street lighting in Salt Lake City, furnishing 276 arc lights at $102 per light, moon-light schedule. It reserves the right, in its contract with the light company, to supply power to motors in units of over 10 HP., and also has the right to reach such users of large power by wires erected on the light company's poles anywhere within the city limits.

It has already closed contracts with two or three other small users of power. The prospective users with whom no contracts have yet been made, consume at present over 2,000 HP. by use of steam. These include various factories, smelters, etc., in the city and at Sandy and Murray, south of it. For those in constant operation day and night, the power costs at present $90 to $145 per HP. per year. Most of the rest are manufactories, running 8 to 10 hours daily, except Sunday, at a cost of $35 to $75 per HP. per year.

It is stated that by the sale of 2,000 or more HP. to these parties the present income of the power company will be increased to $150,000 or more per annum. It is also figured that the earning capacity of the plant will be $200,000 if the current can be marketed so as to allow the maximum load that can be carried to be used.

A branch line is now nearly completed, called the Murray line. This leaves the main line about midway of its length and extends west on 16th South St. (outside the Salt Lake City limits) to State St., a distance of 3½ miles. Here is located a sub-station, a small brick building containing three 100 K-W. air-blast transformers, wound at a ratio of 10 to 1, and giving a secondary production of 2,200 volts.

From here a line is to be extended north two miles to the "Husler Mill," a 150-bbl. flouring mill. Power will be supplied here through a 30-HP. 220-volt induction motor. From the sub-station is being run a heavy secondary or 2,200-volt line to the village of Murray, one mile to the south. This town will be lighted by the electric current.

Several large smelters and similar works are located here and expect to use the current for lighting, and also for power when the necessary changes can be made. The sub-station at Murray has a capacity for handling 500 K-W. The smelters are run day and night the year around.

The Murray line has one circuit of three wires, the poles being of the same size as for the main line.

Cost, Income, Etc.

The construction cost of the completed system has been $325,100, distributed as follows:

Dam, reservoir and all appurtenances and head works, and 430-ft. tunnel	$56,350
Wooden stave pipe, constructed	8,540
Wooden stave pipe intake	400
Reservoir intake	1,760
Steel pipe and connections	41,250
Power house, foundations and tail-race	14,800
Travelling crane	1,400
Water wheels, pipe connections and regulators	13,175
Electrical machinery and equipment	96,200
Transmission line to Salt Lake City	58,100
Engineering superintendence, office expense, etc.	35,125
Total	$325,100

The annual operating expenses of the system when working at full capacity, including expenses of office, management and taxes, is put at $18,000, which, from the detailed figures it is based on, seems a liberal allowance.

The company has a 25-year franchise for the transmission and distribution of electrical energy from Big Cottonwood canyon to all places in Salt Lake county, and one for the same time for distributing light and power through all the streets and public places of Salt Lake City.

The following figures show the cost of the installation per HP. on different assumptions:

1. Actual cost of construction.....$325,100
   Actual minimum water power, 2,400 HP., or $135.50 per HP.
2. Construction cost as before 325,100
   Actual station capacity and usual power, 3,000 HP., or $108.25 per HP.
3. Net value the "Stairs" division..... 400,100
   Usual available power, 3,000 HP., or $133.60 per HP.

The net value is obtained by adding $75,000 to the construction cost, being $25 per HP. for water-right.

All work on the construction of this plant was by day labor, and no expense was spared to make all parts the most secure and substantial possible.

The steel pipe was furnished by Fraser & Chalmers, of Chicago; the wood pipe was built by the power company itself; the water wheels were furnished by the Pelton Water-Wheel Co., of New York and San Francisco; the wire by the John A. Roebling Sons Co., of Trenton, N. J.; the electrical generators and all equipments by the General Electric Co., and the regulating apparatus and local machine and foundry work by Silver Bros., of Salt Lake City. All parts of the system have worked very smoothly. It was stated that a few days after starting up, the greatest flood in 35 years poured through the canyon, with no damage whatever to any of the works.

Besides the completed "Stairs" division, the company has two other water power rights on the same creek, which it proposes to develop as follows:

I. Granite Mills Division.—This division begins nearly one mile within the canyon and extends to the mouth. It is principally based on the water rights and property once belonging to the Granite Paper Mills Co. This company had a paper mill at the mouth of the canyon, with water power machinery. The power development consisted of an open ditch with 8-ft. bottom and 5-ft. depth, leading water from the creek for 3,300 ft. along the hill-side or north side of the canyon. Here the supply to the mill consisted of a flume 8 × 4½ × 130 ft., leading out from the hill to a penstock 8 × 8 × 24 ft., from the bottom of which a single-riveted steel pipe of 48 to 38 ins. diameter and 460 ft. long led down to a Leffel 26½-in. horizontal turbine in the mill, giving a working head of 132 ft.

The mill burned down in 1892, leaving the walls standing, and the entire property has since come into possession of the water power company. Five brick dwelling houses and 200 acres of patented land, with irrigation water rights, are also included, the improvements all being situated thereon. A side-hill grade for wood pipe had been started, tapping the creek 1,200 ft. higher up. By carrying water to the contemplated station site, 1,000 ft. below the old mill, a static head of 357 ft. will be obtained, giving, with minimum supply from the creek of 3,400 cu. ft. per min., 2,300 HP.

II. Mill "B" and Mineral Forks Division.—This division begins at the head of the "Stairs" division and extends up the creek for a distance of over 2½ miles, with a fall of nearly 900 ft. The improvements consist of an old saw-mill and its intervening water rights and some 2,800 lin. ft. of side-hill grade for new construction.

The "Stairs" development and installation of water power, according to modern methods, was the pioneer of such projects in Utah, and the example set thereby has largely stimulated interest and called attention to other possibilities. The many streams draining the west slope of the Wasatch Range afford some ideal advantages for the production of water power, which have been fully realized and grasped by other projectors.

The officers of the Big Cottonwood Power Co. are: Col. J. W. Donnellan, President; W. H. Rowe, Vice-President; Geo. M. Cannon, Secretary; R. M. Jones, Engineer and Manager; J. W. Sumnerhayes, Member Executive Committee, all of whom have worked in unison to carry the construction to successful completion. The engineering work in all departments was done by Mr. R. M. Jones.

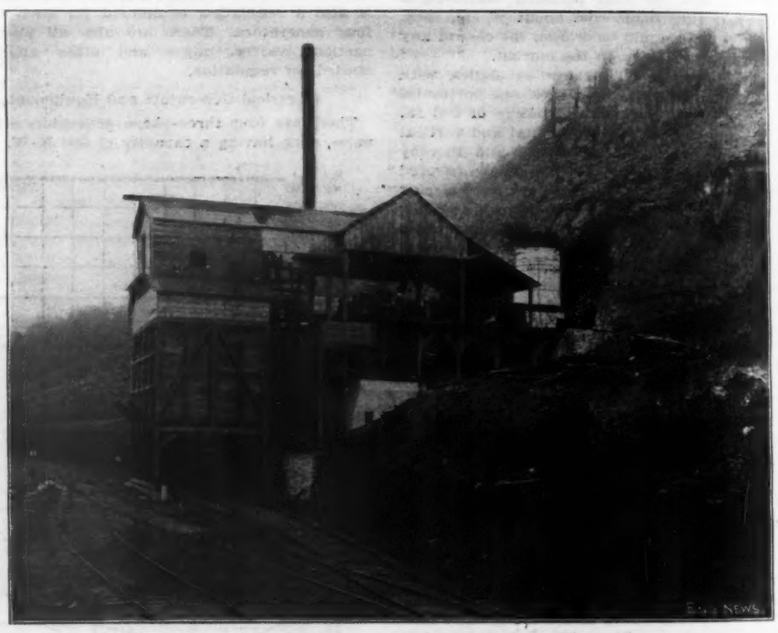


FIG. 1.—ROCK CRUSHING PLANT OF THE NEW ENGLAND TRAP ROCK CO., WESTFIELD, MASS.

A MODERN STONE-CRUSHING PLANT.

A very large stone crushing plant has recently been erected by the New England Trap Rock Co., at its quarries near Westfield, Mass., on the line of the New York, New Haven & Hartford R. R. The plant (Fig. 1) is situated on a level with the quarry, which is not more than 100 ft. distant, running along the side of the mountain. The rock is excavated by means of drills and dynamite and is broken up and loaded into end dump cars. These deliver it to the crushers, of which there are three, all of them of the "Farrel" (Blake pattern), 36 × 18 ins., set on substantial concrete foundations (Fig. 2). The total weight of each crusher is about 50,000 lbs. The capacity of each varies from 300 to 800 tons in ten hours, according to the size to which the pieces are broken,

The driving pulleys are run at about 275 revs. per minute and about 40 HP. is required to operate each crusher. The crushed rock as it leaves the machine slides down a chute directly into steel elevator buckets which carry it up and discharge it into two 48-in. steel sizing screens.

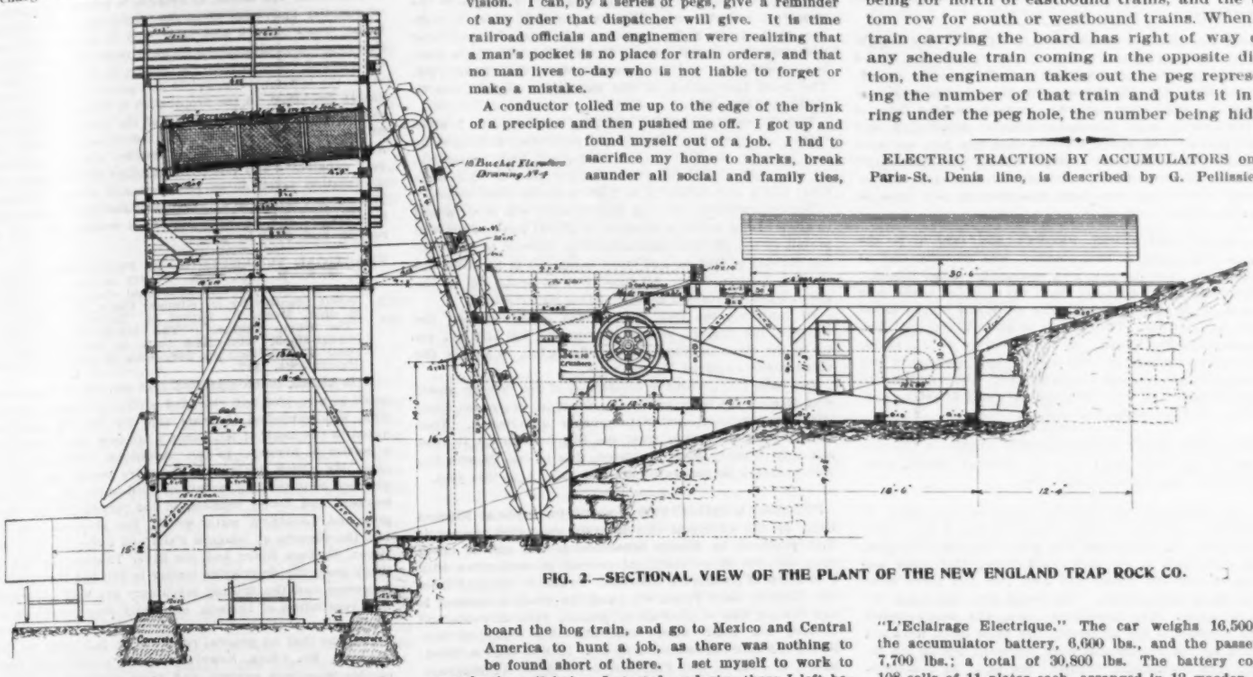


FIG. 2.—SECTIONAL VIEW OF THE PLANT OF THE NEW ENGLAND TRAP ROCK CO.

Each of these screens is about 18 ft. long and is composed of three sections, each with different perforations, which sort the broken stone into three separate bins. The screens are inclined ¾-in. to the foot. Pieces which are too large to pass any section of the screen are returned by a conveyor to the crushers. Doors similar to those used in coaling chutes permit the crushed stone to be drawn off either from the side or from the bottom of the bins. The crushers and all other machinery are driven by a 20 × 24-in. horizontal engine, especially designed for this work. The engine is coupled direct to a jack shaft to which the crushers are connected by leather belts. Steam is supplied by horizontal tubular boilers, which also supply steam to the drills in the quarry. The entire work has been done in the very best manner throughout, with the intention of making it a first-class plant in every respect. The plant has a capacity of 1,000 tons per day and cost complete about $25,000.

The officers of the New England Trap Rock Co. are: President, N. A. Harwood, Chester, Mass.; Treasurer, E. A. Carter, Springfield, Mass.; Manager, J. A. Talmadge, Westfield, Mass.

The entire plant, including the engine, crushers, bins, etc., was designed and erected for the New England Trap Rock Co. by Mr. Earle C. Bacon, M. Am. Soc. M. E., Havemeyer Building, New York city. We are indebted to Mr. Bacon for the matter from which this article and our illustrations are prepared.

TRAIN ORDER BOARD FOR LOCOMOTIVE CABS.

The forgetting of train orders by the engineman has always been a fruitful source of railway collisions, and though steps have been taken to check this by impressing the order upon the man's mind by directing him to read it aloud to his fireman, forgetfulness is still a too frequent cause of accidents. On some roads the train order is placed in a frame in the cab, where the men can see it, but a still better plan is a graphic reminder in the shape of a train order board, with pegs marking the meeting points or stations. This device is shown in the accompanying cut, reproduced from a photograph sent us by the inventor, Mr. A. W. Jennings, of McComb, Miss., who describes it as follows in a letter to "Locomotive Engineering:"

I send you photographs of a device which I have been granted a patent on. One is an order file for the use of locomotive engineers; the other a board containing the names, in cast aluminum letters, of all stations on the division. I can, by a series of pegs, give a reminder of any order that dispatcher will give. It is time railroad officials and enginemen were realizing that a man's pocket is no place for train orders, and that no man lives to-day who is not liable to forget or make a mistake.

A conductor toiled me up to the edge of the brink of a precipice and then pushed me off. I got up and found myself out of a job. I had to sacrifice my home to sharks, break asunder all social and family ties, board the hog train, and go to Mexico and Central America to hunt a job, as there was nothing to be found short of there. I set myself to work to remedy the evil before I started, and give those I left behind with a job some protection against losing it.

On the board I use red peg to denote meeting point between two extras—the numbers of regular trains opposite the station where they are to meet. A white peg for the terminus of an extra. A peg with red cross on black background for wait order. The two rows of numbers at bottom of board are schedule trains. The numbers of trains having right of track over train carrying board only will be left in sight.

A Train Order Board for Locomotive Cabs.

In a letter to us respecting this device, Mr. Jennings says that his file is 8×12 ins., and his order board is 6×18 ins., and costs about $3. The train carrying the board shown has orders to meet train No. 55 at Beauregard, therefore the peg is stuck opposite the name of this station or meeting point. The two bottom rows of pegs represent the schedule trains on the division, the top row being for north or eastbound trains, and the bottom row for south or westbound trains. When the train carrying the board has right of way over any schedule train coming in the opposite direction, the engineman takes out the peg representing the number of that train and puts it in the ring under the peg hole, the number being hidden.

ELECTRIC TRACTION BY ACCUMULATORS on the Paris-St. Denis line, is described by G. Pellissier in "L'Eclairage Electrique." The car weighs 16,500 lbs.; the accumulator battery, 6,600 lbs., and the passengers, 7,700 lbs.; a total of 30,800 lbs. The battery contains 108 cells of 11 plates each, arranged in 12 wooden boxes, 6 on each side of the car. These boxes can be withdrawn and replaced by charged boxes in 6 minutes. When fully charged the car can run 37 miles on the Broca type of rail, and twice that distance on a T-rail. The cost per car-mile of operating the car is set down at 14.48 cts., as compared with 9.24 cts. per car-mile for overhead electric traction in Paris. This cost is divided as follows: Handling accumulators, 1.84 cts.; maintenance of same, 3.08 cts.; maintenance of motors and trucks, 1.56 cts.; motive power, 5.54 cts.; wages and superintendence, 2.46 cts. With a new accumulator system lately tried the cost is stated to be only 10.46 cts. per car-mile.

A GAS EXPOSITION, the first of the kind in this country, is to be held in Madison Square Garden, New York, beginning Jan. 25, 1897, under the auspices of the Gas Industries Company. The full program has not yet been published but the list of officers and directors of the managing company include many well-known men whose names should be a guarantee of success. Among these men are Hon. Calvin S. Brice, New York; Gen. Asa A. Bushnell, of Ohio; Thomas Dolan, of Philadelphia; Gen. James H. Jourdan, of Brooklyn; Dr. Henry Morton, of the Stevens Institute; Prof. T. C. Mendenhall, late Superintendent U. S. Coast Survey; Thomas F. Rowland, Brooklyn; Frank Tilford, New York; and Walter Wood, of Philadelphia. Space is to be allotted to intending exhibitors on Oct. 15.

THE PHILADELPHIA & READING R. R. was sold at auction at Philadelphia, Pa., Sept. 23, and was bid in by Mr. C. H. Coster, representing J. P. Morgan & Co., for $4,500,000, this including the property of the railway company and the coal and iron company. Notice was given on behalf of the city of Philadelphia that the contract entered into between the city and the railway for the construction of a subway would have to be carried out under the new order of things, and that the city of Philadelphia, as trustee under the will of Stephen Girard, would not consent to the immediate transfer of the coal lands which have been leased to the railway company. Under the reorganization the annual charges will be lessened $717,900. The present fixed charges of the railway and coal and iron companies aggregate $10,035,073, and under the reorganization they will be $9,317,173.

THROUGH TRAINS TO TREMONT over the New York elevated railways have now been put in service, the trains running from the Battery to 177th St. Formerly the trains only ran to the Harlem River and passengers had to change cars, while now the trains run through and only a single fare of 5 cts. is charged for the run of 12½ miles.

WHITEHEAD TORPEDOES are being made by the E. W. Bliss Co., of Brooklyn, and the first five will be ready for testing on Nov. 1. In all 100 18-in. twin-screw torpedoes were contracted for, the price being $315,000. These torpedoes are 18 ft. long and carry 250 lbs. of dynamite. The motive power is compressed air stored within the shell and the extreme range is one mile. The Bliss Company has already made 250 torpedoes for the government.

A 12-IN. BROWN SEGMENTAL WIRE-WOUND GUN is recommended by the Ordnance and Fortification Board and an appropriation of $33,000 is made from the experimental fund for this purpose. A gun of this type was tested two years ago and 200 rounds were fired from it at remarkably high pressures without developing any weak points. The Board believes that this test warrants further experiments with a larger caliber and make their recommendations with the approval of Secretary of War Lamont. This gun was fully described in our issue of Nov. 24, 1892.

A HUGE CAST-STEEL PROPELLER, said to be the largest ever made in this country, was recently cast at Chester, Pa., for the new iron steamship "John Englis." It measures 16 ft. diameter from tip to tip of blade, and the hub is 26 ins. diameter. The thickness of the metal at the hub is 6 ins. The casting weighed 15,000 lbs. The steamship "John Englis" is 312 ft. long, 46 ft. beam, with a gross tonnage of 4,000 tons, and is intended to run between New York and Portland, Me. The engines are triple-expansion, of 4,000 HP. and they will drive the propeller at 90 revolutions per minute.

THE FIRST HEAT OF BESSEMER STEEL in the new works of the Troy Steel Co., on Breaker Island, near Troy, N. Y., was made on Sept. 15.

A TOREDO-PROOF PAINT, invented by Thos. J. Childerson, of Pensacola, Fla., has been tested by a naval commission. In March last four pieces of solid heart pine wood were sunk at the navy yard there. One piece was unpainted and the others had one, two and three coats of the paint respectively. The pieces were raised and examined lately. The unpainted piece was honeycombed by the toredo and fell to pieces. The other three were not touched by the insects and were perfectly dry in the interior. The commission reported the paint as a success. We take the above from Washington press dispatches. It is certainly important if true.

THE BOSTON PNEUMATIC TRANSIT CO. has received permission from the aldermen of that city to lay and operate a series of underground conduits for the transmission of mail matter, messages, packages and other articles. A similar order of the board was vetoed last year by Mayor Curtis, and a bill was later passed by the legislature removing the legal obstructions to its passage by the board of aldermen. The mayor now has ten days in which to consider whether he shall approve or veto the franchise.

RESOLUTIONS GRANTING ELECTRIC LIGHT, telephone and subway franchises have been vetoed by Mayor McGuire, of Syracuse, N. Y. The grantees are said to be practically identical in each case. The principal ground for the veto was that the franchises provide for no compensation to the city.

A STONE CRUSHER DRIVEN BY AN ELECTRIC motor is in successful operation at Peterboro, Canada, the current being furnished from the station of the Peterboro Light & Power Co., a mile distant. The motor is of 65 HP. capacity, and it runs the crusher readily when the latter is jammed full of the hardest stones obtainable.

THE WATER-POWER PLANT AT OGDEN, UTAH, of the Pioneer Electric Power Co. was described in detail in our issue of Nov. 8, 1894, by our special contributor, Mr. W. P. Hardesty, C. E. This extensive enterprise involves the development of about 10,000 HP. and the transmission by electricity of a considerable portion at a potential of 15,000 volts to Salt Lake City, a distance of 36 miles. The work has now proceeded so far that the company has awarded the contract to the General Electric Co. for the electrical machinery. The reservoir, dam and pipe line were described in our former article. In the power-house will be placed five Knight water-wheels made by the Risdon Iron & Locomotive Works, of San Francisco, running at 300 revolutions per minute and controlled by Knight automatic governors. Upon each water-wheel shaft will be mounted a 24-pole, three-phase generator wound for 2,300 volts and with a periodicity of 60 cycles per second. Two independent 100 K-W. exciter dynamos, each driven by its own water-wheel, will be placed, and the current from either will be sufficient to charge the fields of all the large machines in the station.

The current from the generators will be carried by lead-covered cables laid in ducts between the generator foundations and the wall of the building to the generator switchboards at one end of the power-house. The boards will have blue Vermont marble panels, and will be completely equipped with all the necessary controlling and regulating instruments and apparatus. Tachometers on the switchboard, operated by synchronous motors electrically connected to the generators, will indicate the speed of the machines.

The step-up transformers and the 2,000 and 15,000 volt feeder panels will be placed in a gallery erected over the generator switchboard. The transformers, nine in number, each of 250 K-W. capacity, will raise the generator potential from 2,300 volts to 15,000 volts, at which pressure 2,000 HP. will be transmitted to Salt Lake City. The local distribution of the balance at Ogden will be made at 2,300 volts.

The transmitted current will pass over six No. 1 wires strung on insulators of a special porcelain, developed by the General Electric Co. to withstand high potentials, to nine 250 K-W. step-down transformers at Salt Lake City, which will deliver it at 2,300 volts for distribution.

The transmission line and transformers will be arranged to allow of the use of a potential of 25,000 volts. This will permit of the efficient transmission of current to the mining regions of Mercur and other camps 30 to 35 miles beyond Salt Lake City. All lines will be protected by the latest types of General Electric lightning arresters.

To construct the iron and wooden pipes bringing the water to the wheels, motors aggregating 100 HP. are set up in the shops of Rhodes Bros., in Ogden, to supply the extra power required for the work.

Salt Lake City, with the completion of the Pioneer plant, will receive power from two of the most important electrical transmission installations ever undertaken. That transmitting the power from the Big Cottonwood Canyon has only recently been completed, that of the Pioneer Co. will probably be inaugurated about Nov. 1 of this year.

POTASSIUM CHLORATE is now being made at Niagara Falls by the Chemical Construction Co. The process is that patented by Henry Blumenberg, Jr., and is based upon the use of an electrical current in connection with a solution of potassium chloride. Power is obtained from the Niagara Falls Power Co., and the product claimed is one ton per day of chlorate of potash, without waste and at very low cost. There are two other electrical processes for this manufacture in use; that of Gall & Montlhauer, of France, and Franchot & Gibbs, of Buckingham, Canada; but this one is said to be the first installed in the United States.

THE ELECTRIC RAILWAY proposed to be built along a boulevard between Baltimore and Washington may be abandoned, the construction company (Baltimore & Catonville Construction Co.) having been put in the hands of receivers. It has been stated by the Columbia & Maryland Ry. Co., however, that the work of building the road will be resumed in about two weeks. It is the intention to complete the Baltimore division to Ellicott City as soon as practicable. Most of the work on this division is finished. Construction on the Washington division will also be started. It is said that funds for carrying on the work will probably be obtained by an issue of receivers' certificates.

CIVIL SERVICE EXAMINATIONS will be held in Brooklyn, N. Y., on Oct. 5, for various positions, including sanitary inspectors, chainman, superintendent of sewer and water pumping station, and also inspectors of plumbing, elevators, buildings, gas and electric work, docks, grading and paving, sewer connections, etc. Mr. E. B. Lent is secretary of the Civil Service Commission, with office in the City Hall.

BOOK REVIEWS.

POOR'S MANUAL of the Railroads of the United States, with an Appendix containing a full analysis of the debts of the United States, the several States, Municipalities, etc. Also statements of Street Railway and Traction Companies, Industrial Corporations, etc. H. V. & H. W. Poor. Twenty-ninth annual number, 1896. New York, 44 Broad St. 8vo.; cloth; pp. 1,670. $7.50.

In our issue of Sept. 3 we gave a brief review of the railway situation in the United States for 1895, as obtained from the advance sheets of the Manual. The work now published for issue contains 258 pages more of matter than the edition of 1895, and embraces statements from 4,390 corporations, aggregating a capitalization of $16,475,000,000. Included in this list are 2,040 railway corporations, 1,208 street railway companies, 143 industrial corporations, and a list of the debts of 1,008 states, counties, cities, towns, etc. This simple statement of the volume of contents, coupled with the care and labor bestowed upon the collection and compilation of this information, is sufficient in itself to indicate the value of the publication.

THE MINERAL INDUSTRY, its statistics, technology and trade in the United States and other countries to the end of 1895. Vol. IV. Edited by Richard P. Rothwell, Editor of the "Engineering and Mining Journal," Past-president American Institute of Mining Engineers, Member American Society of Civil Engineers, Fellow Royal Statistical Society, etc. Statistical Supplement to the "Engineering and Mining Journal." New York and London. Scientific Publishing Company. 8vo.; 849 pp. $5.00.

This fourth issue of what is undoubtedly the most thorough and exhaustive publication of this character anywhere exceeds in value even its predecessors. It is impossible to enter here into a review of the contents of these hundreds of pages, and the general scope can only be indicated. The editor, in addition to giving the statistics of quantity and value of product for seventy-odd separate items, treats of each separately, and in almost every case this supplemental material forms a technical treatise upon the methods of treatment, according to the latest discoveries, the mining, tests, prices and general status of the industry discussed. In the preparation of this matter the editor has been assisted by many of the ablest investigators in the development of mineral industries in Europe and America, and some of these articles are in themselves very exhaustive and especially valuable for the figures and information given as to processes and general progress. The subject matter is arranged alphabetically by item and by country, and an excellent index enables the user to readily find what he wants.

PRACTICAL TUNNELLING.—By Fred'k Walter Simms, F. G. S., M. Inst. C. E. Fourth edition, revised and greatly extended, with additional chapters illustrating recent practice by D. Kinnear Clark, M. Inst. C. E., M. Inst. Mech. E., author of "Railway Machinery," "The Steam Engine," "The Mechanical Engineer's Pocket-Book," etc. New York: D. Van Nostrand Co. 1896. Large 8vo.; pp. 548, with 36 plates and other illustrations. $12.

It is almost to be regretted that Mr. Clark issued this work as a revised and extended edition of Simm's Tunnelling, last published 18 years ago; for the 188 pages devoted to the work of Mr. Simm's are now only valuable as a matter of history. In the "Additional Chapters," however, Mr. Clark deals with the more recent and modern practice of tunnelling, as exemplified in the Mt. Cenis, St. Gothard and Totley tunnels, in the tunnels for the Glasgow and Liverpool water-works, the proposed Simplon, and the tunnels at Niagara Falls and under the St. Clair River, Hudson River and the River Thames. In each of these cases the descriptive matter is full and the sections, processes and the drilling machinery are well illustrated. The ventilation of tunnels, especially long tunnels, is an engineering problem so complicated by controlling local conditions that no general rules can be laid down for this purpose. Mr. Clark, however, devotes considerable space to this important subject, and gives examples of various attempts made to get rid of foul air and details the results of such experiments for a number of prominent tunnels. Tunnel practice in America is scarcely touched upon; the exception being the tunnels under the Hudson and the St. Clair rivers, and the Niagara Falls power tunnel. Mr. Clark's work is valuable, however, in bringing together in one volume much scattered information relating to European tunnel work; and while this descriptive matter is made as concise and brief as possible, and useful details are thus omitted, the work as a whole is to be commended.

WATER SUPPLY.—(Considered Principally from a Sanitary Standpoint). By William P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute. New York: John Wiley & Sons. London: Chapman & Hall. 8vo.; cloth; pp. 504; illustrations and tables; $5.

This book occupies, to a considerable extent, a middle ground between Fanning's "Water Supply Engineering" and Hazen's "Filtration of Public Water Supplies," without infringing upon the territory of either. It resembles in its general plan Nichols' "Water Supply, Considered Mainly from a Chemical and Sanitary Standpoint," but supersedes it, owing to the advances made in the subject since Professor Nichols' work appeared.

The volume opens, practically, with a long and valuable chapter on "Drinking Water and Disease," a subject to which the author has given much attention. A portion of this chapter was printed in Engineering News of June 4, 1896, under the title, "Does Pure Water Pay?" Next comes a chapter on "Artificial Purification of Water," which is principally devoted to a general description of slow sand filtration, and rapid sand, or mechanical, filtration. Natural purification of water is then discussed, the principal sub-heads here being: "Direct Oxidation," "Sedimentation," "The Purifying Action of Sunlight," "Self-purification of Streams," and "Seasonal Variation in Purity of Streams."

After having discussed these subjects, the various sources, or classes of sources, of water supply are taken up in four chapters, these chapters being preceded by one on "Rain, Ice and Snow."

The principles underlying the chemical and bacterial examination of water, together with the methods employed, are treated in two chapters, and another chapter is devoted to consumption of water per inhabitant, a subject having a very important bearing on the sanitary phases of water supply.

The concluding chapter reviews in an able manner the present understanding of the action of water on metals, and includes some remarks on pipe preservatives. A number of appendices present, among other things, some tables of analyses of city water supplies, statistics of typhoid death rates in American and foreign cities.

Altogether the book promises to be a useful one, while its general make-up is pleasing.